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TECHNICAL MANUAL
SERVICE INSTRUCTIONS

FAIR RADIO SALES CO., INC.
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RADIO RECEIVERS
R-278/GR
R-278A/GR
R-278B/GR

COLLINS RADIO COMPANY, CEDAR RAPIDS, IOWA
F34601-72-D-0655

BASIC AND ALL CHANGES HAVE BEEN MERGED TO MAKE THIS A COMPLETE PUBLICATION.

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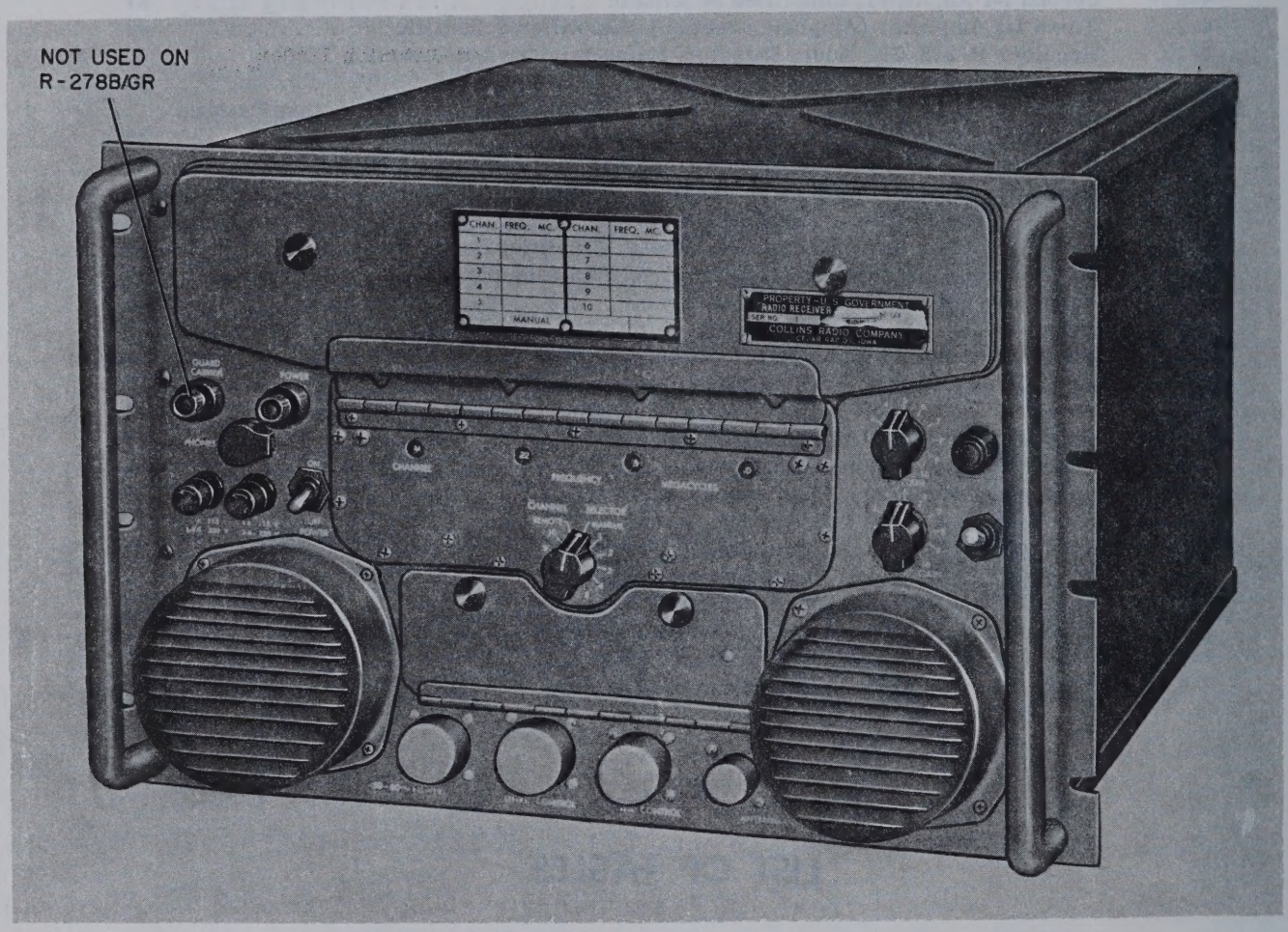


Figure 1-1. Radio Receiver R-278/GR (R-278A/GR and R-278B/GR)

SECTION I
DESCRIPTION AND LEADING PARTICULARS

1-1. GENERAL.

1-2. This publication comprises service instructions for Radio Receivers R-278/GR, R-278A/GR and R-278B/GR. (See figure 1-1.) The following publications also contain information pertaining to this equipment:

a. Handbook Operating Instructions, Radio Set AN/GRC-27 (T.O. 31R2-2GRC27-1).

b. Handbook Overhaul Instructions, Radio Receivers R-278/GR, R-278A/GR and R-278B/GR (T.O. 31R2-2GRC27-13).

1-3. ASSOCIATED EQUIPMENT.

1-4. Radio Receiver R-278/GR (R-278A/GR or R-278B/GR), as described in this publication, is intended for use as part of Radio Set AN/GRC-27. Other equipments which also form part of Radio Set AN/GRC-27 are Radio Transmitter T-217A/GR, Modulator-Power Supply MD-129A/GR, Distribution Panel J-390/GR, Antennas AT-197/GR and AS-505 (-A-B)/GR, Rack MT-686/GR, Desk Shelf MX-1058/U, Electrical Conduit MX-1174/U and various cabling.

1-5. PURPOSE OF OVERALL SYSTEM.

1-6. Radio Set AN/GRC-27 is a ground radio control air base installation. It is intended for communications with aircraft having similar radio sets operating in the uhf band, such as AN/ARC-19, AN/ARC-27 and AN/ARC-33.

1-7. PURPOSE OF RADIO RECEIVERS R-278/GR, R-278A/GR AND R-278B/GR.

1-8. Radio Receiver R-278/GR is a ground station receiver designed to provide reception of amplitude-modulated radiotelephone and radiotelegraph signals on any one of 1750 channels in the frequency range of from 225.0 to 399.0 mc. Radio Receivers R-278A/GR and R-278B/GR have the added feature of supplying a 30-cps detected signal for use in conjunction with Radio Direction Finder AN/CRD-6. Although receiver R-278/GR will have a 30-cps output when receiving signals modulated with 30 cps, this output does not meet the requirements of the direction finding system. Receiver R-278/GR and receiver R-278A/GR (up to serial number 1727) were designed to incorporate a guard channel receiver section. Since this section is not included in those receivers now in the field, the receiver may be made operational by adding jumper wires between pins 1 and 2 and between pins 3 and 4 of the guard channel receiver main cable female connector J1207. The antenna input "T" connector is also bypassed by connecting plug P1202 to plug P1203. Receiver R-278A/GR (from serial number 1728) and receiver R-278B/GR were not designed to include the guard channel receiver.

NOTE

Radio Receivers R-278/GR, R-278A/GR and R-278B/GR are all the same basic receiver. Whenever reference is made to R-278/GR, it applies equally to R-278A/GR and R-278B/GR except where otherwise specified.

1-9. ELECTRICAL DESCRIPTION.

1-10. Radio Receiver R-278/GR employs a triple-conversion superheterodyne system using crystal-controlled oscillators employing a total of 38 crystal units. A motor-driven frequency selector unit operates the various crystal switches and tuning mechanisms of the receiver to permit rapid change of operating frequency.

1-11. The frequency selector unit is controlled by a switch panel which permits the operating frequencies of 11 channels to be preset. Ten of the 11 preset channels can be selected by operation of a channel selector switch on the front panel of the receiver or by means of various remote control facilities. The eleventh or manual channel can be selected only from the panel-mounted channel selector switch.

1-12. Radio Receiver R-278/GR operates from either a 115- or 230-volt, 50/60-cycle power source and is designed for use with directional or omni-directional antennas having a characteristic impedance of 52 ohms. Audio output circuits for operation of loudspeakers and for operation into telephone lines are provided. A special 30-cps output circuit for direction finding applications is also incorporated in Radio Receivers R-278A/GR and R-278B/GR. The receiver is equipped with automatic volume control, automatic noise limiting and carrier-operated relay circuits.

1-13. Radio Receiver R-278/GR is designed for operation with Radio Set Control C-565/GR, Control Indicator C-806/GR and other remote control facilities.

1-14. PHYSICAL DESCRIPTION.

1-15. Radio Receiver R-278/GR is contained in a single cabinet designed for mounting in Rack MT-686/GR for fixed-base or mobile shelter type operation, or in submersion-or-shock-proof Case CY-722/GR for field operation. The dust cover of the receiver

is equipped with stainless steel feet to permit mounting on a table or bench. An interlock switch at the rear of the receiver removes the supply voltage from the set when the dust cover is removed. This interlock switch may be defeated for the purpose of dynamic servicing.

1-16. Radio Receiver R-278/GR contains 10 subassemblies. These subassemblies may be removed individually from the basic frame by loosening the retaining screws, releasing mechanical couplings, where used, and lifting out the unit. Each subassembly is electrically connected to the system by a cable that plugs into a receptacle on the basic frame. In this way, a subassembly may be removed from the basic frame but still be electrically connected in the system for purposes of maintenance and alignment checks.

1-17. All operating controls are mounted on the front panel of the receiver. This panel can be detached from the basic frame to provide access to control wiring. Radio Receiver R-278/GR is cooled by a system of forced ventilation. A blower located at the lower right-hand corner of the receiver front panel draws in the air through an air filter, circulates it through the receiver and out through an air filter on the lower left-hand side of the front panel. The overall dimensions of the receiver are 19 inches in width, 12-1/4 inches in height, and 20 inches in depth.

1-18. CHARACTERISTICS OF UHF COMMUNICATIONS.

1-19. The use of uhf makes physical layout of components, lengths of leads, mechanical couplings, clean and tight fittings, and systematic service procedures of prime importance in satisfactory equipment performance. The reasons for the adoption of uhf communication and the seemingly complex radio equipment are as follows:

a. There is much more "room" at these higher frequencies. This equipment utilizes 1750 channels separated by 100 kc in this frequency band. The lower frequency bands are very crowded and must be reserved for long distance communication for which their characteristics are suited.

b. "Line-of-sight" type propagation improves military security, reduces the possibility of interference between stations and permits many stations to use the same frequency, providing they are spearated by a few hundred miles.

c. Little or no atmospheric noise is encountered. This is of utmost importance since lower frequency radio is seriously affected and may be made useless by storm or other atmospheric disturbances.

d. Antennas can be made smaller and simpler in structure both on aircraft and on the ground. Good directional characteristics can be obtained for point-to-point type of communications.

1-20. CONDENSED FACTUAL DATA.

1-21. LIST OF EQUIPMENT SUPPLIED.

1-22. Table I lists the subassemblies which constitute Radio Receiver R-278/GR.

1-23. ELECTRON TUBE COMPLEMENT.

1-24. Table II lists the tubes used in Radio Receiver R-278/GR.

TABLE I. LIST OF EQUIPMENT SUPPLIED

COMMON NAME OF COMPONENT OR SUBASSEMBLY	FIGURE	OFFICIAL NOMENCLATURE OF COMPONENT OR SUBASSEMBLY	REFERENCE DESIGNATION
Receiver	1-1	Radio Receiver R-278/GR, (R-278A/GR, R-278B/GR)	
R-f Amplifier	1-2	Amplifier, Radio Frequency	101-199
* Main Oscillator	1-3	Oscillator, Radio Frequency	201-299
Frequency Multiplier-Amplifier	1-2	Amplifier, Radio Frequency	301-399
First I-f Amplifier	1-2	Amplifier, Intermediate Frequency	401-499
Second I-f Amplifier	1-2	Amplifier, Intermediate Frequency	501-599

* Also shown in bottom view of Radio Receiver R-278B/GR (figure 1-4).

TABLE I. LIST OF EQUIPMENT SUPPLIED (cont)

COMMON NAME OF COMPONENT OR SUBASSEMBLY	FIGURE	OFFICIAL NOMENCLATURE OF COMPONENT OR SUBASSEMBLY	REFERENCE DESIGNATION
* Third I-f Amplifier	1-3	Amplifier, Intermediate Frequency	601-699
* Audio Amplifier	1-3	Amplifier, Audio Frequency	801-899
Power Supply Rectifier	1-2	Power Supply	901-999
D-c Filter	1-2	Filter, Direct Current Power	1001-1099
Frequency Selector	1-2	Control Unit, Frequency	1101-1199
Receiver Frame	1-2		1201-1399

* Also shown in bottom view of Radio Receiver R-278B/GR (figure 1-4).

TABLE II. ELECTRON TUBE COMPLEMENT

REFERENCE SYMBOL	JAN TYPE NO.	FUNCTION
R-f Amplifier		
V101	6J4WA	R-f Amplifier
V102	6J4WA	R-f Amplifier
Main Oscillator		
V201	12AT7WA	UHF Oscillator
Frequency Multiplier-Amplifier		
V301	5654/6AK5W	Frequency Multiplier
V302	5654/6AK5W	Frequency Multiplier
V303	6J4WA	Injection Amplifier
V304	6J4WA	Injection Amplifier
V305	6J4WA	Injection Amplifier
First I-f Amplifier		
V401	5654/6AK5W	Mixer
V402	5654/6AK5W	I-f Amplifier
V403	5654/6AK5W	Mixer
V404	12AT7WA	Oscillator
Second I-f Amplifier		
V501	6AU6	I-f Amplifier
V502	5814A	Oscillator-Mixer

TABLE II. ELECTRON TUBE COMPLEMENT (cont)

REFERENCE SYMBOL	JAN TYPE NO.	FUNCTION
Third I-f Amplifier		
V601	5749/6BA6W	I-f Amplifier
V602	5749/6BA6W	I-f Amplifier
*V603	6AU6	I-f Amplifier
V604	5726/6AL5W	Audio and AVC Detector
V605	5726/6AL5W	Noise Limiter
V606	5814A	Cathode Follower
V607	5814A	AVC Gate-DF Detector
V608	12AX7	Carrier-Operated Relay Control-Noise Cancellation Detector
V609	6C4	Carrier-Operated Relay Control Amplifier
Audio Amplifier		
V801	5814A	Audio Amplifier
V802	6006/6AQ5W	Audio Output Amplifier
V803	6005/6AQ5W	Audio Output Amplifier
V804	OA2	Voltage Regulator
Power Supply Rectifier		
V901	3B22	Rectifier
V902	3B22	Rectifier
V903	6X4W	Bias Rectifier

*Type 5749/6BA6W in R-278A/GR and R-278B/GR.

TABLE III. FUSE COMPLEMENT

REFERENCE SYMBOL	TYPE	RATING (AMPS) 115V	230V
(On Receiver Frame)			
F1201	3AG	3.0	1.5
F1202	3AG	5.0	3.0
F1203	8AG	0.6	0.6

1-25. FUSE COMPLEMENT.

1-26. Table III lists the fuses used in Radio Receiver R-278/GR.

1-27. CONTROLS AND INDICATORS.

1-28. Table IV lists the controls and indicators used in Radio Receiver R-278/GR and references the illustrations that show their locations. The column in the table headed "CLASS" classifies the controls and indicators as either O (operating) or M (maintenance). O items are those that are under the control of the operator during normal operation of the equipment. M items are those requiring preadjustment or which are actuated only during maintenance or alignment periods.

1-29. SUMMARY OF EQUIPMENT CHARACTERISTICS.

1-30. Table V lists the pertinent characteristics of Radio Receivers R-278/GR, R-278A/GR and R-278B/GR.

1-31. DIFFERENCE DATA SHEETS.

1-32. Sections I through VII of this handbook apply to Radio Receivers R-278/GR, R-278A/GR and R-278B/GR. Additional models of this equipment will be covered in Section VIII by the use of difference data sheets.

TABLE IV. CONTROLS AND INDICATORS

COMPONENT	ITEM	CLASS	FUNCTION	FIG. NO.
R-f Amplifier	R-f Tuners (Z101, Z102, Z103)	M	Tune the r-f input circuits.	6-1
Main Oscillator	R-f Coils (L222-L239)	M	Tune the output frequencies of the main oscillator.	6-1
	Rotary Switches (S201, S204)	M	Automatically select one of eighteen crystal-generated output frequencies.	6-1
	Thermostatic Switches (S202, S203)	M	Maintain proper crystal oven temperature.	6-1
	Thermal Switch (S205)	M	Removes oven power if temperature exceeds set value.	6-1
Frequency Multiplier-Amplifier	R-f Tuners (Z301, Z303)	M	Tune the frequency multiplier stages of the frequency multiplier-amplifier.	6-1
	R-f Tuners (Z305, Z307, Z309)	M	Tune the amplifier stages of the frequency multiplier-amplifier.	6-1
First I-f Amplifier	Capacitors (C403, C407, C414, C417, C421, C425)	M	Provide partial alignment for tuning transformers T401, T402 and T403.	6-2
	R-f Coils (L402-L405, L407, L408)	M	Provide partial alignment for tuning transformers T401, T402 and T403.	6-2
	Rotary Switch (S401)	M	Automatically selects one of ten crystal-generated frequencies for the 1.0 mc function.	6-2
Second I-f Amplifier	R-f Coils (L501-L504)	M	Provide alignment for tuning transformers T401 and T502.	6-2
	Rotary Switch (S501)	M	Automatically selects one of ten crystal-generated frequencies for the 0.1 mc function.	6-2
Third I-f Amplifier	R-f Coils (L601-L608)	M	Provide alignment for tuning transformers T601 through T604.	6-3
Power Supply Rectifier	Switches (S901, S902)	M	Set the receiver for either 115-volt or 230-volt operation.	6-2

TABLE IV. CONTROLS AND INDICATORS (cont)

COMPONENT	ITEM	CLASS	FUNCTION	FIG. NO.
Frequency Selector	CHANNEL SELECTOR (S1101)	O	Selects one of ten preset frequencies or a channel using a manual selection of frequency.	3-1
	Rotary Switch (S1102)	M	Automatically selects the desired channel.	6-4
	Rotary Switches (S1103, S1104)	M	Automatically select the desired frequency in the 10-mc range.	6-4
	Rotary Switch (S1105)	M	Automatically selects the desired frequency in the 1-mc range.	6-4
	Rotary Switch (S1106)	M	Automatically selects the desired frequency in the 0.1-mc range.	6-4
	Rotary Switches (S1107-S1117)	M	Automatically provide selection and indication of the selected 10-mc range.	6-4
	Rotary Switches (S1118-S1128)	M	Automatically provide selection and indication of the selected 1-mc range.	6-4
	Rotary Switches (S1129-S1139)	M	Automatically provide selection and indication of the selected 0.1-mc range.	6-4
Receiver Frame	*GUARD CARRIER (I1201)	O	Not used.	
	POWER (I1202)	O	Indicates that power is being applied to the receiver.	3-1
	MAIN CARRIER (I1203)	O	Indicates that a signal is being received.	3-1
	*GUARD RF GAIN (R1202)	O	Not used.	
	QUIETING (R1204)	O	Sets the noise level of the receiver when no signal is present.	3-1
	AF GAIN (R1205)	O	Adjusts the audio output level on the phones used in conjunction with the receiver.	3-1
	MAIN RF GAIN (RF GAIN on R-278B/GR) (R1207)	O	Sets the level at which squelch circuit operation is removed.	3-1
	POWER (S1201)	O	Applies power to receiver.	3-1

TABLE IV. CONTROLS AND INDICATORS (cont)

COMPONENT	ITEM	CLASS	FUNCTION	FIG. NO.
	AVC (RF GAIN on R-278B/GR) (S1202)	O	Determines whether avc voltage is applied to or removed from the receiver.	3-1
	FREQ. RESPONSE (S1203)	O	Selects either a broad or narrow audio frequency response.	3-1
	AVC TIME CONSTANT (S1204)	O	Selects either a 1/10-second or a 1-second avc time constant.	3-1
	SQUELCH (S1205)	O	Determines whether or not the receiver will be squelched during periods of radio silence.	3-1
	Interlock Switch (S1206)	O	Removes primary power from the receiver when the dust cover is removed.	6-1
	Tracking Control Switch (S1207)	M	Permits positioning of the 10-mc autopositioner to gain access to the various adjustments.	6-1

*Not incorporated in Radio Receiver R-278B/GR.

TABLE V. SUMMARY OF EQUIPMENT CHARACTERISTICS

FEATURE	DESCRIPTION
Frequency Range	225.0 to 399.9 mc
Number of Operating Frequencies	1750 spaced at 0.1-mc intervals
Number of Preset Channels	10 selected remotely plus 1 selected locally
Channel Change Time	Not more than 5 seconds
Type of Frequency Control	Quartz crystals
Number of Crystal Units	38
Type of Receiver	Triple-conversion superheterodyne with automatic tuning, automatic noise limiting, delayed and amplified automatic volume control and carrier-operated relay circuits.
Sensitivity	At maximum setting of the RF GAIN control, a 6-microvolt signal with 30-percent modulation at 1000 cps will produce not less than 1.0 watt output at not less than 10 db signal-to-noise ratio.

TABLE V. SUMMARY OF EQUIPMENT CHARACTERISTICS (cont)

FEATURE	DESCRIPTION
Selectivity	Bandwidth not less than 85 kc (65 kc for R-278A/GR and R-278B/GR) at 6 db attenuation; not more than 225 kc (185 kc for R-278A/GR and R-278B/GR) at 60 db attenuation.
Frequency Stability	∓ 10 kc
Image Frequency Rejection	More than 60 db below input signal level.
Intermediate Frequency Rejection	More than 80 db below input signal frequency level.
Types of Reception	Voice: amplitude-modulated radio-telephony Tone: mcw
Input Impedance	52 ohms
Output Characteristics:	
Main Output	3 watts into 600-ohm balanced load
Auxiliary Output	+ 10 dbm into 600-ohm termination at the AUX. CONTROL connector and the LOCAL CONTROL connector.
Direction Finder Output	Cathode follower type output for direction finding equipment available at AUX. CONTROL connector. (Although receiver R-278/GR will have a 30-cps output when receiving signals modulated with 30 cps, this output does not meet the requirements of the direction finding system. Receivers R-278A/GR and R-278B/GR do meet the requirements of the direction finding system.)
Audio Frequency Responses:	
Broad	Flat within 4 db from 200 to 20,000 cps
Narrow	Frequency in Cycles — DB Attenuation 200 — greater than 10 400 — less than 5 1000 — 0 3000 — less than 5 5000 — greater than 10
Distortion	Less than 5 percent at 30-percent modulation and 3 watts output.
AVC Characteristics	Audio output constant: a. within ∓ 2 db for signal input from 10 microvolts to 0.1 volt b. within ∓ 6 db for signal input from 0.1 volt to 2 volts

TABLE V. SUMMARY OF EQUIPMENT CHARACTERISTICS (cont)

FEATURE	DESCRIPTION	
AVC Time Constants:		
Short (COMM)	1/10-second (for communication)	
Long (D/F)	Approximately 3 seconds (for direction finding operation).	
Carrier-Operated Relay Sensitivity	3.0-microvolt or more r-f signal input sufficient to cause operation of relay at maximum setting of RF GAIN control.	
Power Requirements:		
A-c Supply Voltage	115 or 230 volts	
A-c Supply Frequency	50/60 cps	
A-c Power Factor	Approximately 95 percent	
	During First 10 Min.	After First 10 Min.
Normal Operation	385 watts	265 watts
Period of Channel Selection	470 watts	350 watts

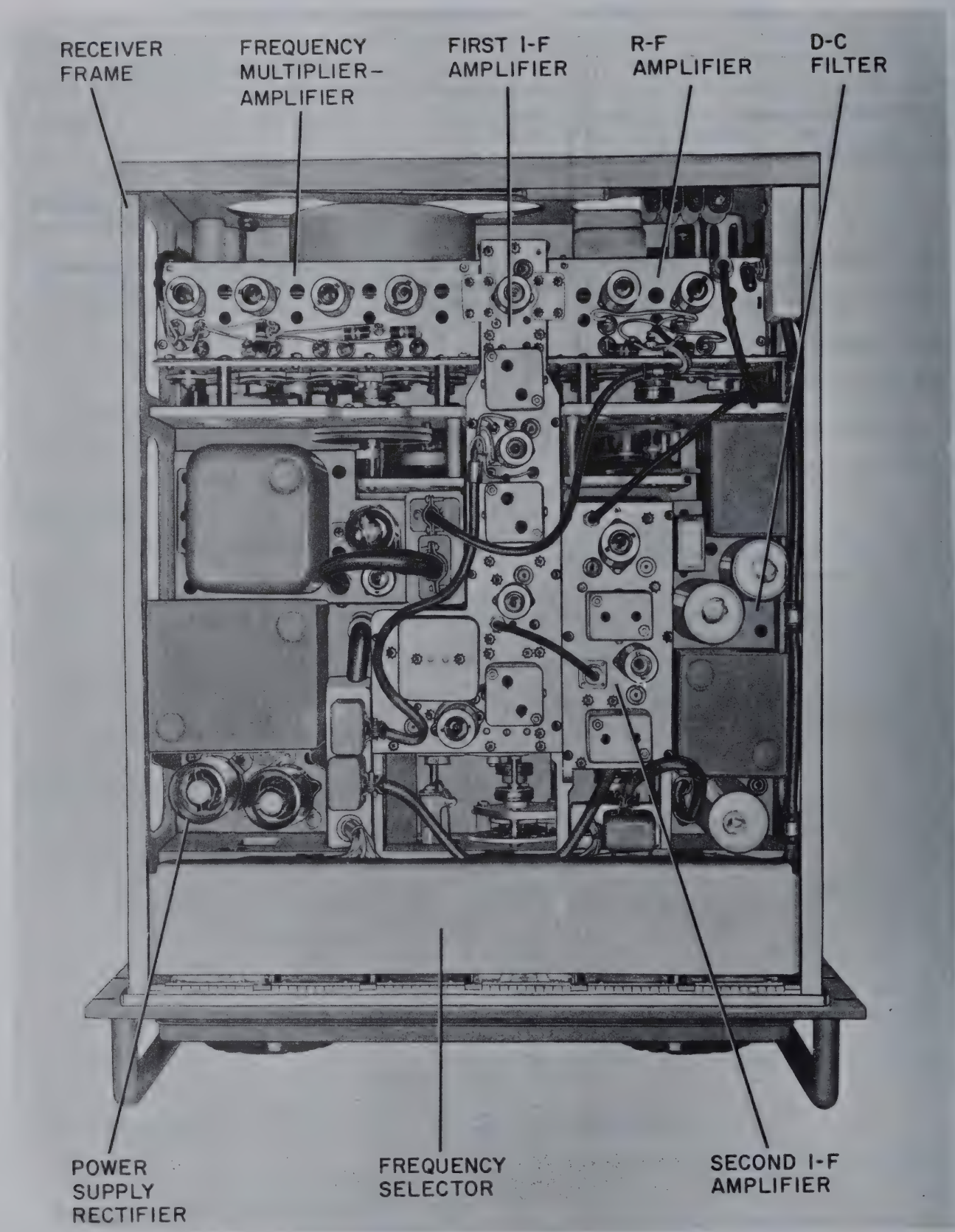


Figure 1-2. Receiver, Top View

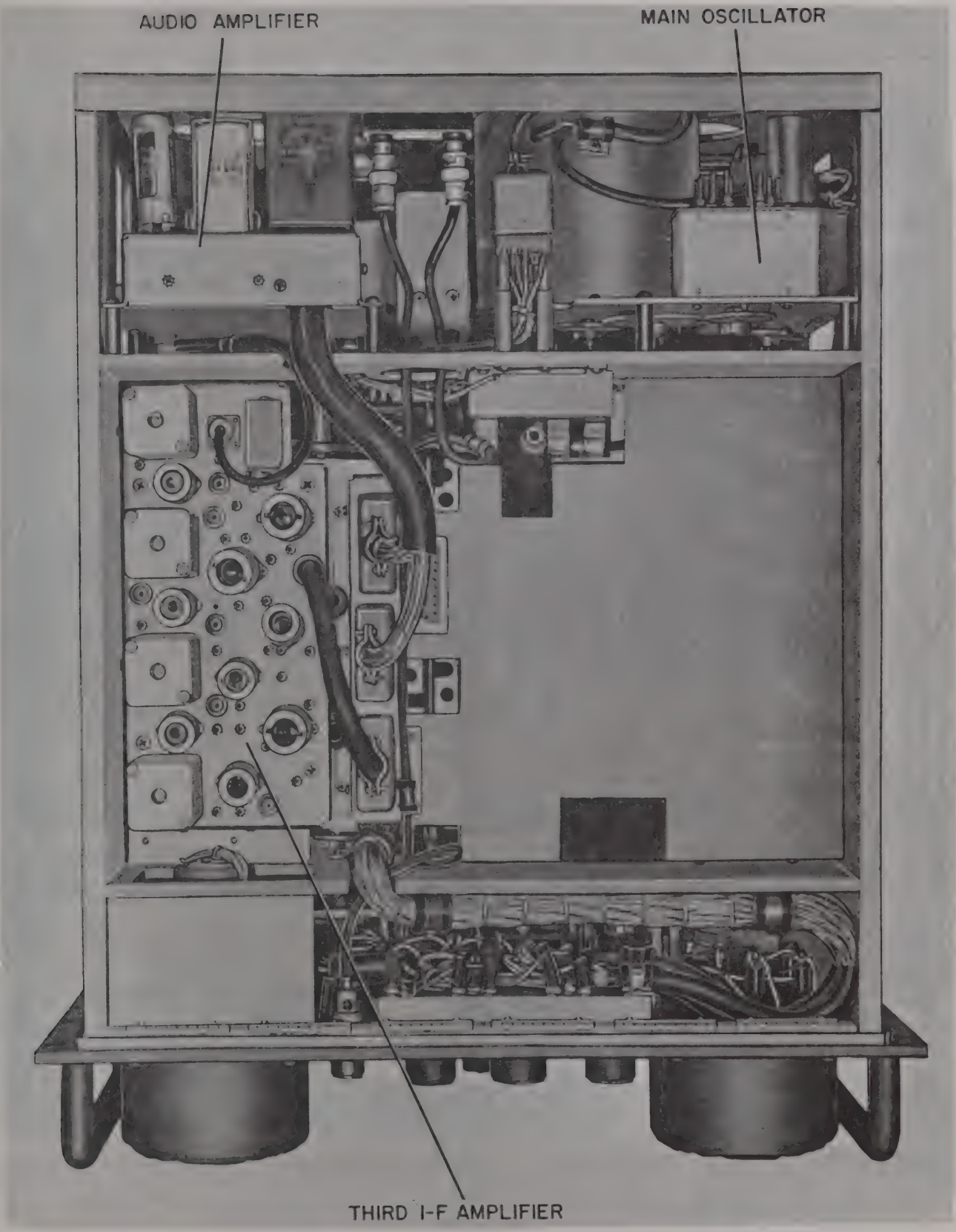


Figure 1-3. Receivers R-278/GR and R-278A/GR, Bottom View

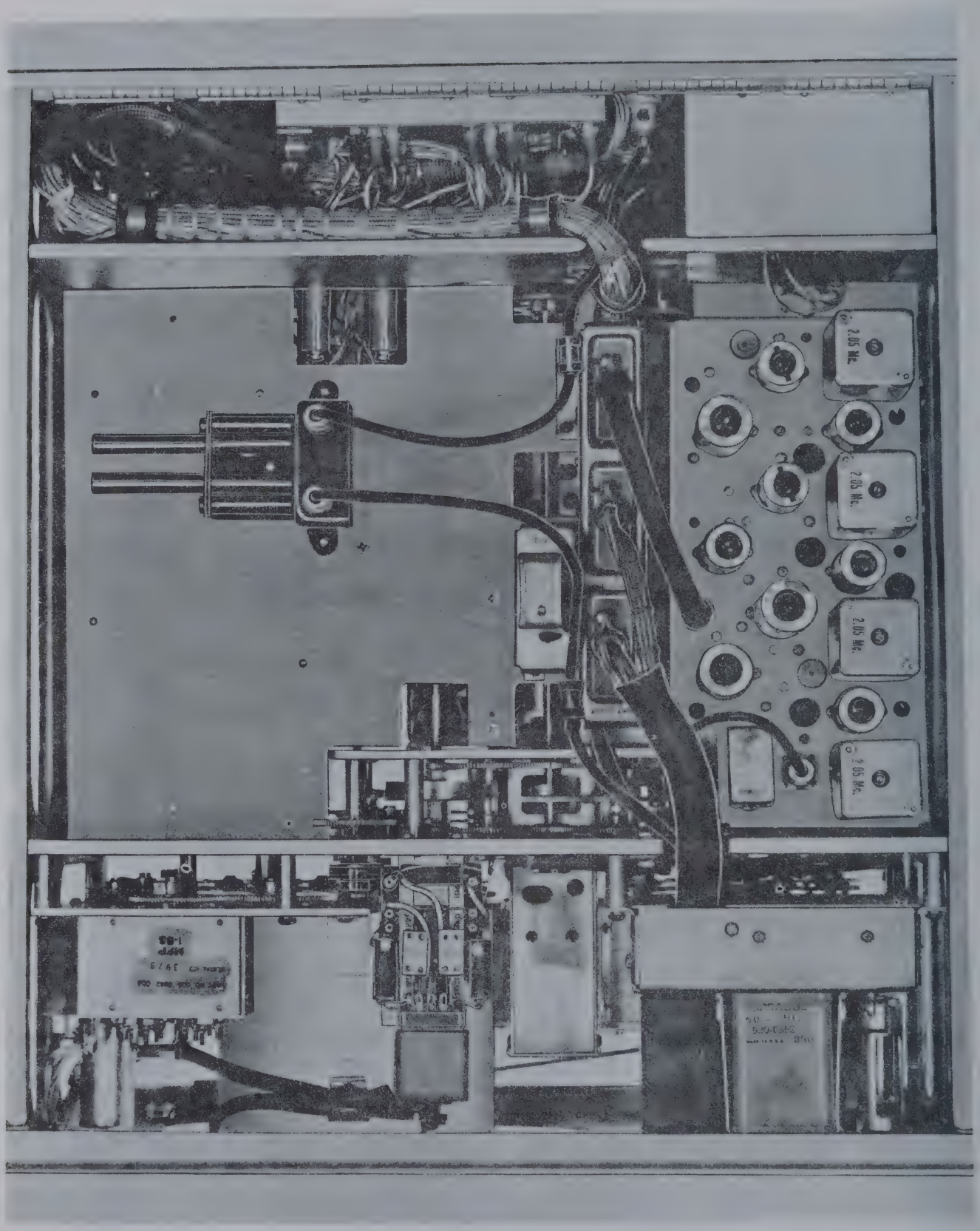


Figure 1-4. Receiver R-278B/GR, Bottom View

SECTION II
TEST EQUIPMENT AND TOOLS

2-1. GENERAL.

2-2. This section lists the test equipment and tools which are required for routine field servicing of Radio Receivers R-278/GR, R-278A/GR and R-278B/GR. If the specific test equipment is not available, a substitute possessing similar characteristics may be used.

2-3. LIST OF TEST EQUIPMENT.

2-4. Table VI lists the test equipment required for routine field maintenance of Radio Receivers R-278/Gr, R-278A/GR and R-278B/GR.

2-5. LIST OF TOOLS.

2-6. Table VII lists the tools required for field maintenance of Radio Receivers R-278/GR, R-278A/GR and R-278B/GR.

TABLE VI. LIST OF TEST EQUIPMENT

NAME	AN TYPE OR MER. DESIGNATION	APPLICATION
R-f Signal Generator	AN/URM-25A	Provides i-f signal injection for alignment procedures.
R-f Signal Generator	AN/USM-44	Provides r-f signal for alignment procedures (used as test transmitter).
Frequency Meter	AN/URM-81	Used as frequency standard and to measure selectivity.
VTVM	375A/U	Used for voltage and resistance measurements.
Oscilloscope	OS-8B/U	Used for waveshape analysis
Audio Oscillator	TS-382A/U	Provides an audio test signal.
Electronic Multimeter	TS-505A/U	Used for general troubleshooting and maintenance.
Audio Output Meter	Daven OP-961	Used for sensitivity measurements.
*Course Generator	Collins 479S	Provides a phase-shift test for checking the DF circuit.
A-c Voltmeter	Ballantine Standard Model 300	Used to measure audio voltages and power supply ripple.

*Not applicable for Radio Receiver R-278/GR.

TABLE VII. LIST OF TOOLS

PART NO.	NOMENCLATURE	APPLICATION
Collins Radio Co. 505 0833 003	Special Tuning Tool	Used for alignment adjustments.
	Tuning Wand (3/16-inch diameter)	Used to check alignment of tuners and i-f amplifier transformers.
	Set of Adapter Plugs	Used to make tube voltage readings possible without removing subassemblies.
Collins Radio Co. 024 0039 00	Non-Metallic Tubing Tool	Used to adjust r-f trimmers.
	Slender tab bending tool made up of blunted scribe with sides ground flat (or equivalent)	Used to adjust r-f tuner tabs.

SECTION III
PREPARATION FOR USE AND RESHIPMENT

3-1. GENERAL.

3-2. When Radio Receiver R-278/GR (R-278A/GR, R-278B/GR) is received from the manufacturer, it must be unpacked, inspected, and installed in its proper mounting.

3-3. UNPACKING.

3-4. Care must be exercised while handling and unpacking the equipment to prevent damage. Set up the crate in the proper position for opening as indicated by markings on the crate. Use a nail-puller to remove the nails. Never drive a bar, claw hammer or other tool under a crate cover to pry it open as damage to the equipment may result. Retain the original packing materials for possible reshipment.

3-5. INSPECTION.

3-6. Check the equipment received against the packing slip and against the list of equipment supplied in Table I. Inspect each unit for damage to the cover, lid, connectors, dials, and mountings. Check all tubes for firm mounting in their sockets and make sure that no glass is broken. Repair or replace any parts that are damaged.

3-7. INSTALLATION.

3-8. Radio Receiver R-278/GR (R-278A/GR, R-278B/GR) is mounted in Rack MT-686/GR. For installation of this unit in the rack, refer to Handbook Operating Instructions, Radio Set AN/GRC-27 (T.O. 31R2-2GRC27-1). Figure 3-2 shows the intercabling between the receiver and other units in the AN/GRC-27 system.

3-9. CABLE FABRICATION.

3-10. The parts for the cable from the receiver to its antenna are furnished in bulk form. To fabricate this r-f cable, affix one connector UG-495A/U to each end of a specified length of RG-17A/U coaxial transmission line. The cable should be no longer than is necessary to reach from the receiver to the antenna. Figure 3-3 shows the procedure for mounting the connectors on the ends of the cables. In the event that repair or replacement of any other cabling is necessary, refer to cable fabrication instructions in figures 3-3 and 3-4.

3-11. RESHIPMENT.

3-12. Retighten any screws that were loosened to remove connections or to remove the unit from its mounting in the rack. If available, place dust cups on each connector plug and receptacle. Check the tubes to see that they ar firmly fastened in their sockets and that all tube shields are properly hooked. Tighten any loose control knobs or any other item that may appear loose. See that lids and other covers are firmly latched.

3-13. Place the unit in the original packing material and in the same manner. If retention of the original packing material was not possible, proceed to pack the unit as follows:

a. Place the unit in a strong cardboard carton and insert blocks to prevent shifting within the carton which may damage the controls.

NOTE

Place the blocking material so that it always makes contact with strong structural parts of the unit. Block the unit from each side of the front panel with strips thick enough to give clearance to the panel controls.

b. Seal the carton with strong tape and place it into a wooden crate (similar to Navy style 2) constructed with 3/4-inch lumber (or plywood equivalent).

c. Float the carton in two or three inches of excelsior.

d. Mark the crate with appropriate identifications and handling warnings.

3-14. EQUIPMENT OPERATION.

3-15. Figure 3-1 illustrates the controls and indicators used in operating Radio Receiver R-278/GR (R-278A/GR, R-278B/GR). For operating instructions on this equipment, refer to Handbook Operating Instructions, Radio Set AN/GRC-27 (T.O. 31R2-2GRC27-1).

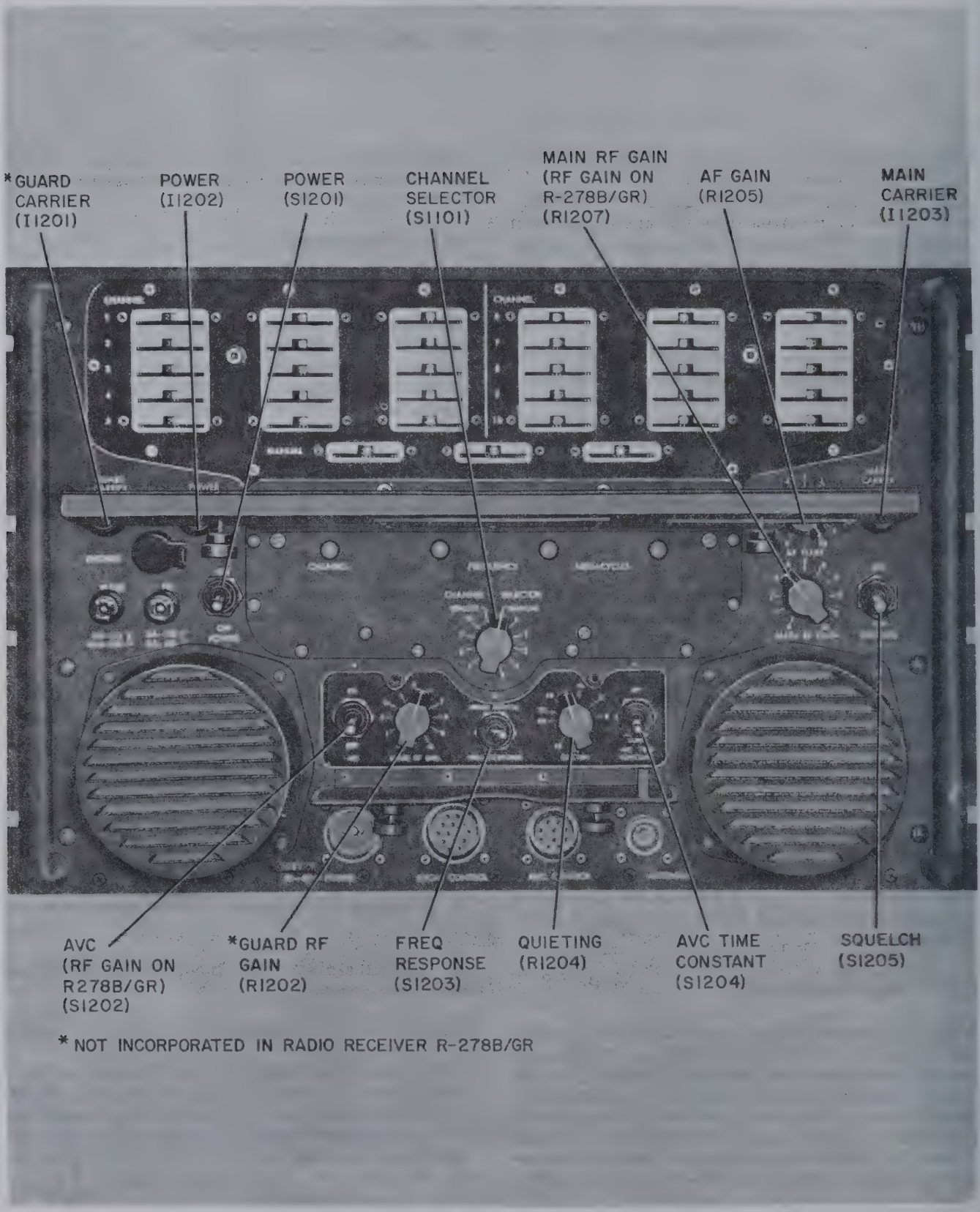
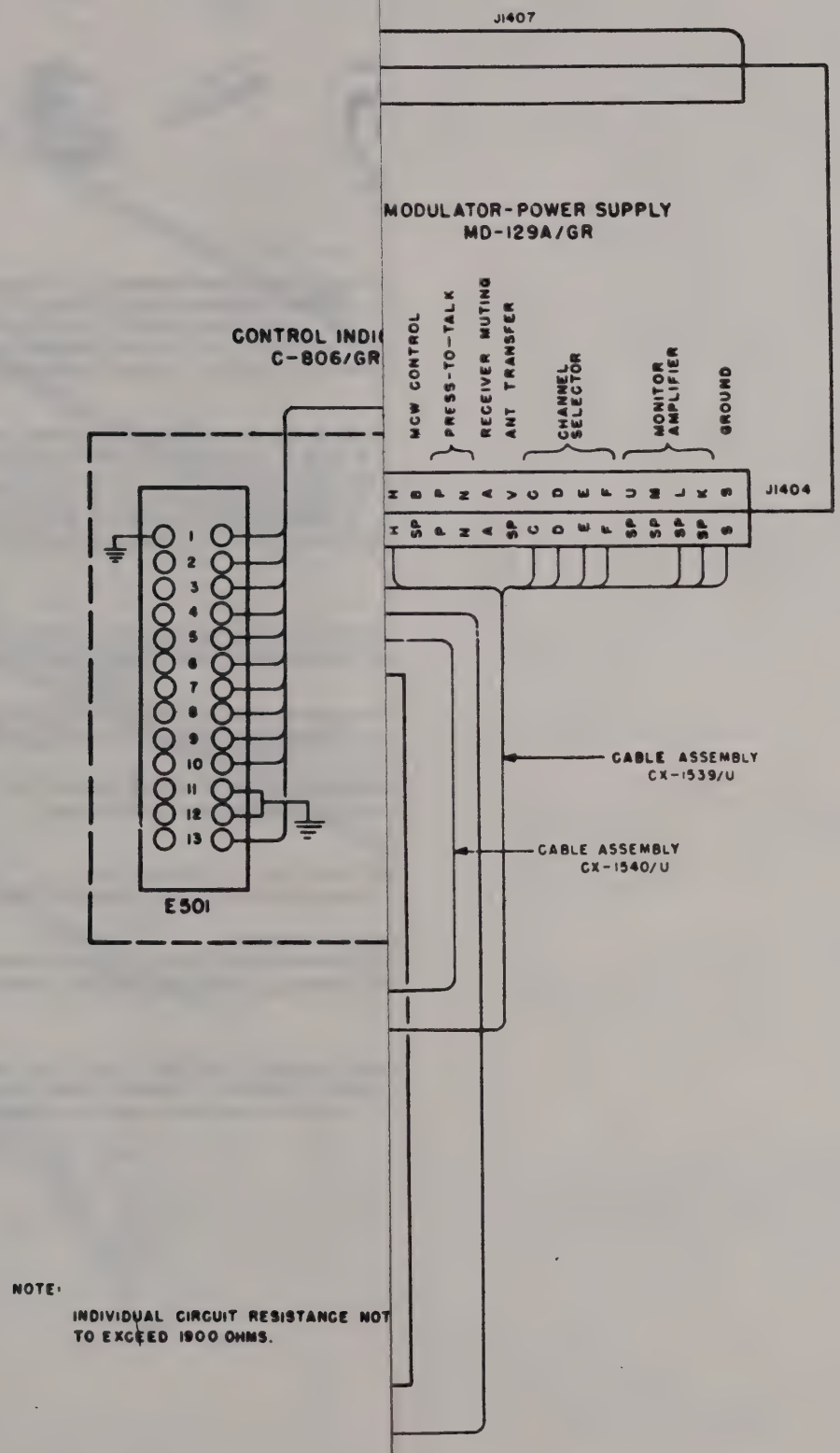


Figure 3-1. Receiver, Operating Controls



NOTE:

INDIVIDUAL CIRCUIT RESISTANCE NOT TO EXCEED 1900 OHMS.

-27, Cabling Diagram

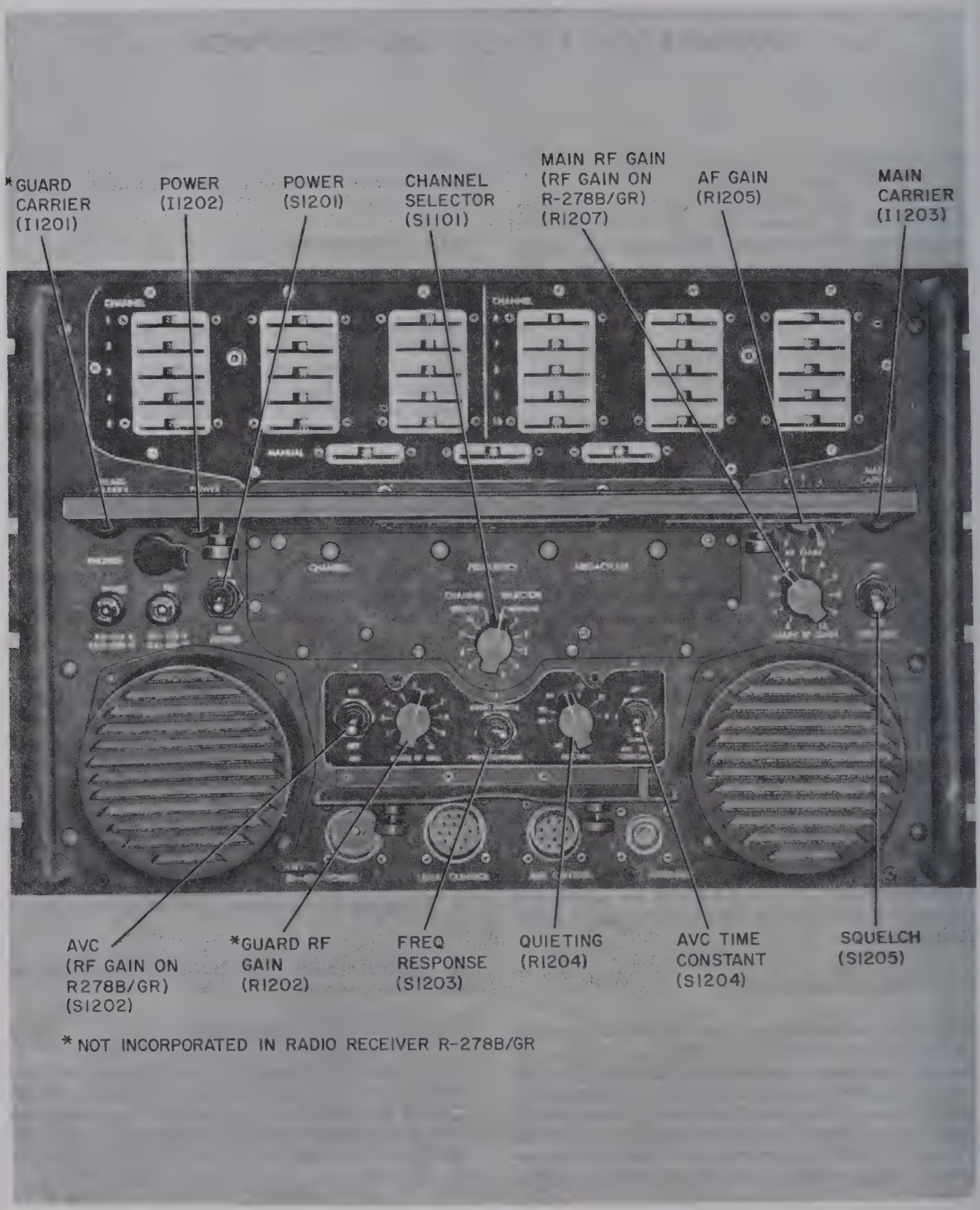


Figure 3-1. Receiver, Operating Controls

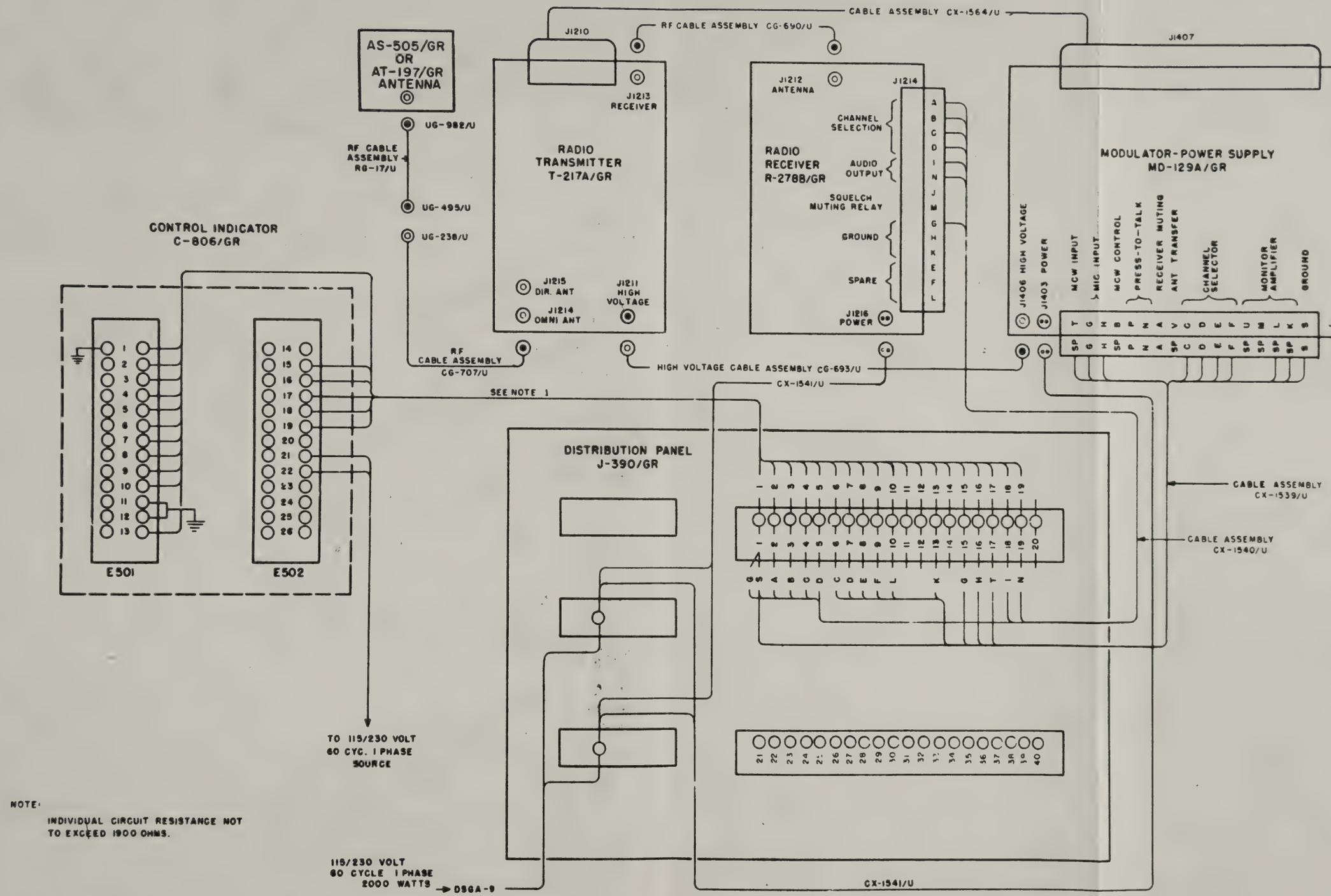
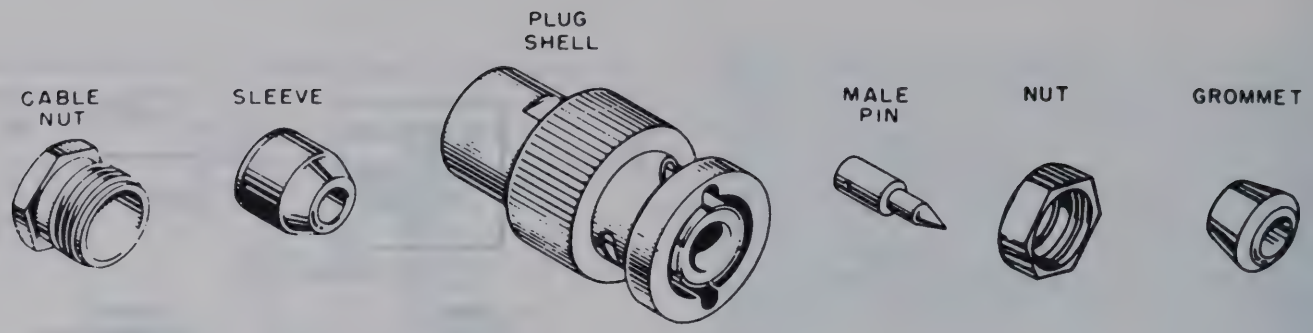
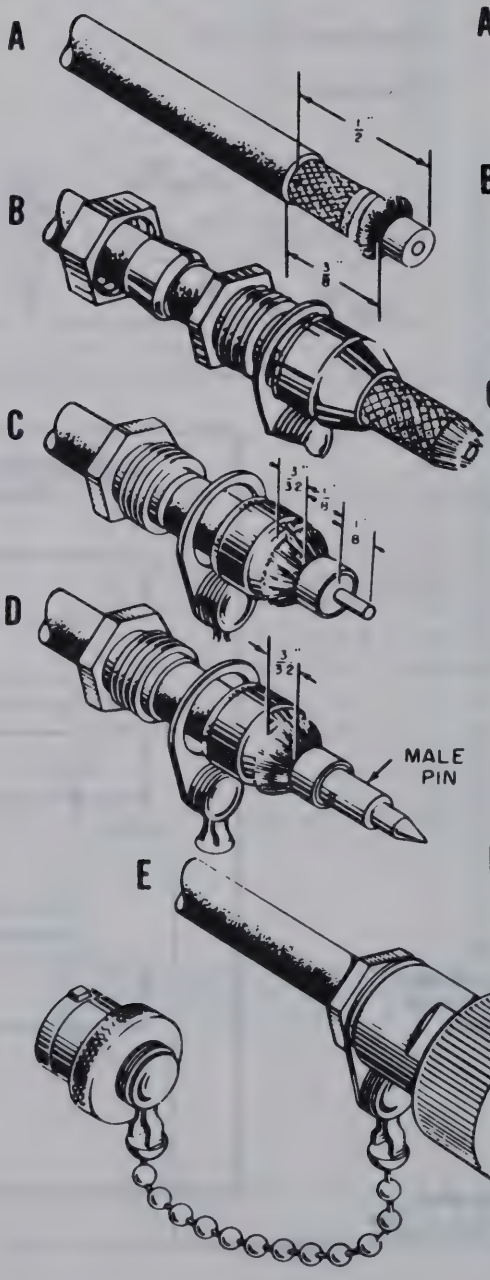


Figure 3-2. AN/GRC-27, Cabling Diagram





A SQUARE OFF THE CABLE ENDS AND REMOVE $\frac{1}{2}$" OF VINYLITE OUTER JACKET AT ENDS. EXPOSING COPPER SHIELD BRAID. TAPE BRAID $\frac{3}{8}$" FROM END AND FAN OUT THE END OF THE BRAID TO PERMIT CUTTING OFF THE INNER HIGH-FREQUENCY INSULATION AND INNER CONDUCTOR $\frac{3}{8}$" FROM END OF VINYLITE OUTER JACKET. REMOVE TAPE.

B TAPER THE BRAID END. SLIDE COMPRESSION NUT AND GROMMET, WHERE USED, OVER CABLE. SLIDE CABLE NUT (REMOVED FROM THE PLUG) ONTO THE CABLE. SLIDE CAP-AND-CHAIN LUG OVER CABLE FOR LATER ASSEMBLY AS SHOWN IN E. REMOVE SLEEVE ASSEMBLY FROM PLUG AND SLIDE IT OVER THE BRAID SO THAT IT FITS SNUGLY AGAINST THE VINYLITE JACKETSHOULDER.

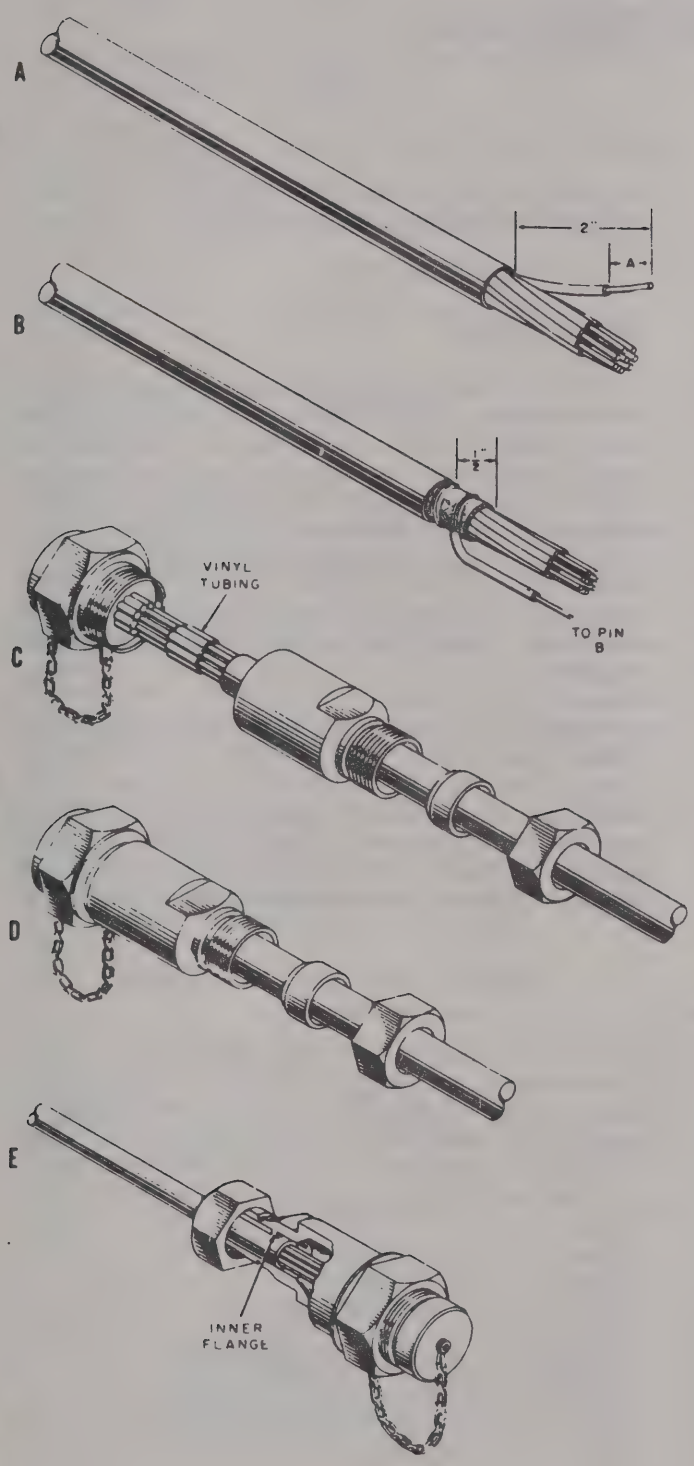
C COMB OUT THE BRAID ALL THE WAY BACK TO THE SLEEVE, FOLD IT BACK OVER THE TAPERED END OF THE SLEEVE, AND TRIM TO $\frac{3}{32}$".

TRIM OFF HIGH-FREQUENCY INSULATION (INCLUDING POLY-ETHYLENE THREAD SUPPORT OF CABLE) AND LEAVE A $\frac{1}{8}$" EXPOSED PORTION.
CUT OFF INNER CONDUCTOR TO $\frac{1}{8}$" FROM INSULATION SHOULDER AND TIN THE EXPOSED INNER CONDUCTOR END.

D TIN THE INSIDE OF THE MALE CONTACT PIN.
SLIP THE INNER CONDUCTOR INTO THE CONTACT PIN AND SOLDER IN PLACE.
REMOVE ALL EXCESS SOLDER.
COAT THE EXPOSED PORTION ($\frac{1}{8}$") OF THE HIGH-FREQUENCY INSULATION WITH A SMALL AMOUNT OF DOW-CORNING NO. 4 COMPOUND.

E PUSH THE PREPARED CABLE END INTO THE PLUG SHELL AS FAR AS IT WILL GO. SLIDE THE NUT FORWARD AND SCREW IT INTO THE PLUG SHELL TIGHTEN SECURELY WITH A WRENCH.

Figure 3-3. Coaxial Cables, Termination Method



A SQUARE OFF THE END OF THE CABLE AND REMOVE 2" OF THE OUTER SHEATH. BE CAREFUL NOT TO INJURE THE INSULATION OF ANY OF THE ENCLOSED CONDUCTORS. STRIP THE INSULATION FROM EACH CONDUCTOR ACCORDING TO THE "A" DIMENSION GIVEN IN THE TABLE. TIN THE EXPOSED ENDS OF THE CONDUCTORS.

B IN THE CASE OF A SHIELDED CABLE - FOR EXAMPLE, W9413- AFTER REMOVAL OF THE OUTER SHEATH AS EXPLAINED IN A, REMOVE THE EXPOSED SHIELDING TO WITHIN $\frac{1}{2}$" OF THE END OF THE OUTER SHEATH. IF REMOVING THE SHIELDING WITH A KNIFE, ALWAYS CUT AWAY FROM THE CABLE, NOT TOWARD IT. A PAIR OF SCISSORS IS USEFUL IN THE REMOVAL AND TRIMMING OF SHIELDING.

STRIP A SUFFICIENT AMOUNT OF INSULATION FROM A STRANDED #16 CONDUCTOR TO ALLOW THE BARED CONDUCTOR TO BE WRAPPED $1\frac{1}{2}$ TIMES AROUND THE SHIELDING. SOLDER IN PLACE. BRING THE FREE END OF THIS WIRE OUT PARALLEL TO THE CABLE CONDUCTORS AND CUT OFF EVEN WITH THE ENDS OF THE OTHER CONDUCTORS. STRIP THE INSULATION FROM THIS FREE END THE SAME AMOUNT AS ON THE OTHER CONDUCTORS.

C SLIDE THE CABLE NUT, FORCE RING, AND PLUG SHELL, IN THIS ORDER, OVER THE CABLE.

SLIDE A PIECE OF THE PROPER SIZE VINYL TUBING OVER EACH OF THE CONDUCTORS.

INSERT EACH CONDUCTOR INTO ITS PROPER PIN OF THE PLUG INSERT *(See Cable Connection Diagrams, Figures 4-21 To 4-26 & 4-30)* AND SOLDER.

NOTE: IN THE CASE OF THE SHIELDED CABLE, THE WIRE CONNECTED TO THE SHIELD *(See B Above)* IS CONNECTED TO PIN B.

AFTER SOLDERING, SLIP THE VINYL TUBING OVER THE CONNECTIONS AND APPLY DOW CORNING # 4 COMPOUND TO THE ASSEMBLY.

D ASSEMBLE THE PLUG AND SHELL BY SLIDING THE SHELL OVER THE SOLDERED CONNECTIONS AND SCREWING THE SHELL ONTO THE PLUG ASSEMBLY, BEING CAREFUL NOT TO TWIST THE CABLE WITH RESPECT TO THE PLUG.

E BEFORE COMPLETING THE ASSEMBLY OF THE PLUG, CHECK THAT THE INNER FLANGE OF THE SHELL OVERLAPS THE OUTER SHEATH OF THE CABLE.

SLIDE THE FORCE RING AND CLAMP NUT OVER THE CABLE TO THE PLUG-AND-SHELL ASSEMBLY, AND SCREW THE CLAMP NUT TIGHTLY ONTO THE PLUG ASSEMBLY.

ASSEMBLE THE CAP ONTO THE PLUG BY ENGAGING THE CAP KEY WITH THE PLUG KEYWAY AND TURN THE NUT ON THE PLUG.

Figure 3-4. Multi-Conductor Coaxial Cables, Termination Method

SECTION IV
THEORY OF OPERATION

4-1. OVERALL OPERATION.

4-2. GENERAL.

4-3. Radio Receiver R-278/GR (R-278A/GR and R-278B/GR) consists of four sections; a receiver section, an audio amplifier, a power supply, and a frequency selector unit. (See figure 4-1.)

4-4. The receiver section operates on one of 1750 channels in the frequency range of 225.0 to 399.9 mc. (See figure 4-2.) This section employs a triple conversion superheterodyne system using three crystal-controlled oscillators. The three crystals used, of 38 available crystals, are selected by a motor-driven frequency selector unit. The frequency selector unit also operates the tuning mechanisms of the receiver.

4-5. The frequency selector unit, controlled by switches on the front panel of the receiver, automatically tunes the receiver to one of 11 preset channels. The receiver can be remotely tuned to any one of ten preset channels when used in conjunction with such units as Radio Set Control C-565/GR or C-566/GR. A manual channel may only be selected locally by a switch on the receiver front panel.

4-6. The power supply section furnishes required voltages to all sections of the receiver.

4-7. RECEIVER SECTION.

4-8. GENERAL.

4-9. The receiver section consists of six removable subassemblies, a main oscillator, a frequency multiplier-amplifier, an r-f amplifier, and a 1st, 2nd, and 3rd i-f amplifier. The receiver operates on any one of 1750 frequencies spaced 0.1 mc apart. It is completely tuned by the frequency selector unit.

4-10. FREQUENCY CONVERSION SYSTEM.

4-11. The receiver is a triple conversion superheterodyne, using the following radio and intermediate frequencies.

R-f amplifier	Tuned in 0.1-mc increments.
*220.0-399.9 mc.	

*Although the frequency range of the receiver is specified as being from 225.0 to 399.9 mc., the frequency system employed is capable of providing 50 additional frequencies in the range of 220.0 to 224.9 mc.

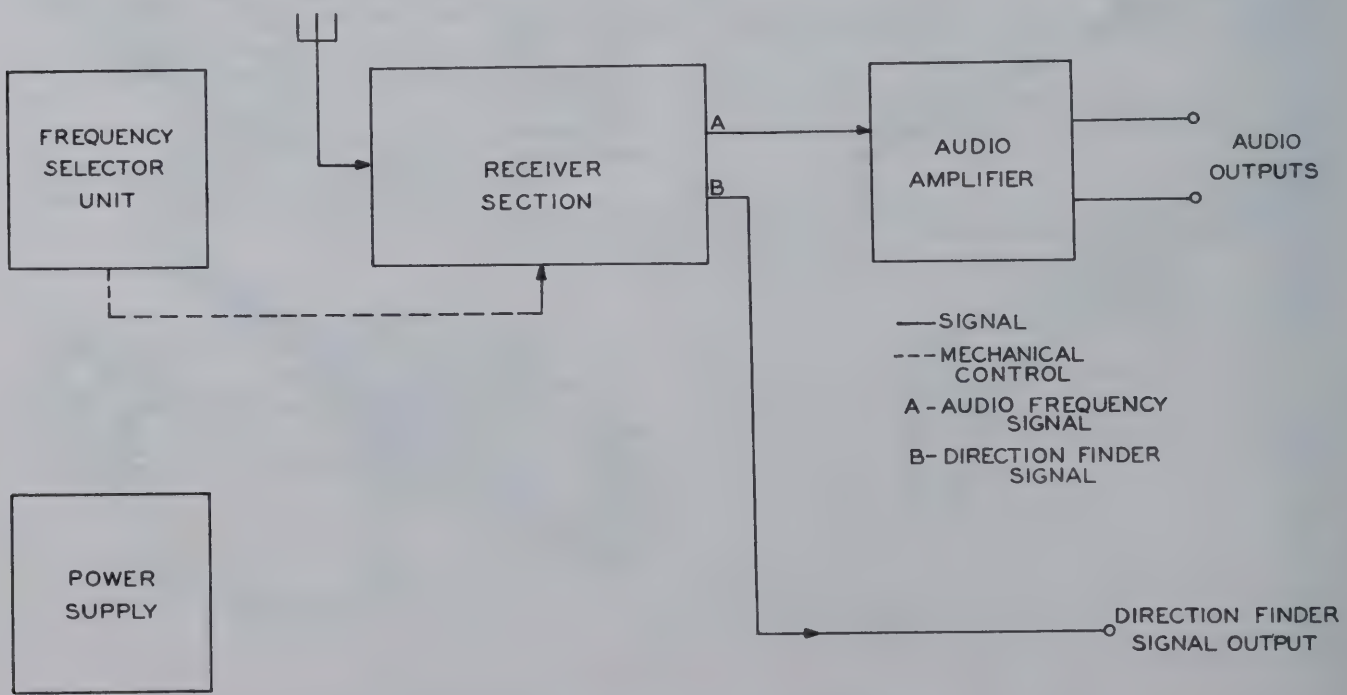


Figure 4-1. Receiver, Simplified Block Diagram

First injection 180.0-350.0 mc.	Tuned in 18 steps of 10 mc each.
First i-f amplifier 40.0- 49.9 mc.	Tuned in 100 steps of 0.1 mc each.
Second injection 31.0- 40.0 mc.	Tuned in 10 steps of 1 mc each.
Second i-f amplifier 9.0- 9.9 mc.	Tuned in 10 steps of 0.1 mc each.
Third injection 6.95- 7.85 mc.	Tuned in 10 steps of 0.1 mc each.
Third i-f amplifier 2.05 mc.	Fixed tuned.

4-12. The r-f amplifier is tuned in 1.0-mc steps to any frequency in the range of 225.0 to 399.9 mc. The first injection system tunes in 10-mc steps to any frequency from 180 to 350 mc. These two frequencies are mixed in the first mixer to produce a first intermediate frequency of 40.0 to 49.9 mc. The first i-f amplifier is tuned to one of 100 frequencies spaced 0.1 mc apart. The second injection system generates one of 10 frequencies in the range of 31.0 to 40.0 mc and mixes this frequency with the output of the first i-f amplifier (40.0 to 49.9 mc) to produce a second intermediate frequency of 9.0 to 9.9 mc. The third injection system generates one of 10 frequencies in the range of 6.95 to 7.85 mc to mix with the output of the second i-f amplifier (9.0 to 9.9 mc) to produce the third intermediate frequency of 2.05 mc.

4-13. FREQUENCY SELECTING SYSTEM.

4-14. The frequency selecting system utilizes a frequency selector unit which is an electromechanical device containing three rotary shafts. These shafts, referred to as the 10-mc, 1.0-mc and 0.1-mc output shafts, select the proper crystal units, and tune the various circuits to establish a particular operating frequency. The 10-mc shaft rotates in 18 incremental steps, each increment representing 10-mc. The 1.0-mc shaft rotates in 10 incremental steps, each step representing 1.0 mc. The 0.1-mc shaft also rotates in 10 incremental steps, each step representing 0.1 mc. By combining the outputs of these shafts and applying the mechanical sum to the tuning of the r-f and i-f circuits, any one of 1750 frequencies in the range of 225.0 to 399.9 mc may be selected.

4-15. The r-f amplifier is tuned in 180 steps of 1.0 mc each by the 10-mc shaft (18 positions) and the 1.0-mc shaft (10 positions), whose rotory motions are combined in a differential mechanism to produce 180 rotational positions. The main oscillator and the frequency multiplier-amplifier (the first injection system) are tuned in 10-mc increments by the 10-mc shaft, which also operates the main oscillator crystal selector switch to select one of 18 crystal units. The first i-f amplifier is tuned in intervals of 0.1 mc by a differential unit positioned by the 1.0- and 0.1-mc shafts to produce 100 steps. The second i-f oscillator crystal selector switch and tuned circuits are directly controlled by the 1.0-mc shaft. The second i-f amplifier is tuned in 10 steps of 0.1 mc each by the 0.1-mc shaft, which also controls the crystal selector switch of the third i-f oscillator.

4-16. FUNCTIONAL OPERATION OF MAJOR CIRCUITS.

4-17. RADIO FREQUENCY AMPLIFIER.

4-18. The radio frequency signal is received and amplified by a two stage, broad-band amplifier. The r-f amplifier tuned circuits are tuned in 180 steps by the 10-mc and 1.0-mc shafts operating through a mechanical differential system.

4-19. FIRST INJECTION SYSTEM.

4-20. The output of the r-f amplifier is heterodyned in the first mixer with a signal from the first injection system to produce a first i-f signal in the frequency range of 40.0 to 49.9 mc. The first injection system consists of a crystal-controlled oscillator and five stages of frequency multiplication and amplification. Eighteen crystals are employed to provide 18 injection frequencies at 10-mc intervals between 180 and 350 mc.

4-21. FIRST I-F AMPLIFIER.

4-22. The first i-f signal is amplified by a one-stage amplifier and two inter-stage transformers which are permeability-tuned by the differential combinations of the 1.0- and 0.1-mc output shafts. The signal is mixed in the second mixer with an injection signal from the second injection system to produce a second intermediate frequency in the range of 9.0 to 9.9 mc. The second injection system consists of a crystal-controlled oscillator utilizing one of 10 crystal units.

4-23. SECOND I-F AMPLIFIER.

4-24. The second i-f signal is amplified by a one-stage amplifier and two inter-stage transformers that are permeability-tuned by the mechanical output of the 0.1-mc output shaft. The signal is then mixed in the third mixer with an injection signal from the third injection system, which uses a crystal-controlled oscillator employing 10 crystal units. The crystal is selected by the 0.1-mc output shaft so that the last intermediate frequency is always 2.05 mc.

4-25. THIRD I-F AMPLIFIER.

4-26. The third i-f signal is amplified by a three stage fixed-tuned i-f amplifier employing four double-tuned transformers.

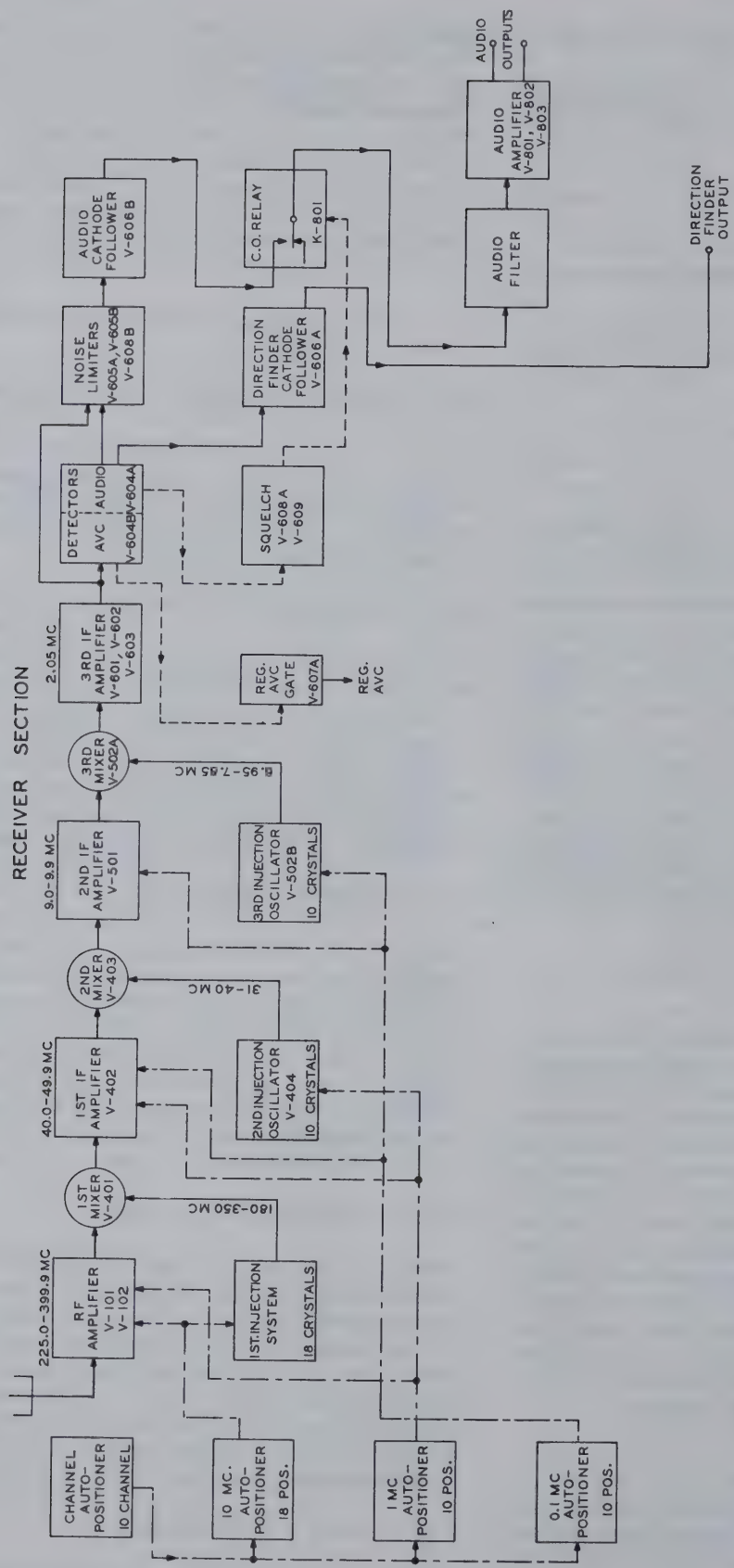


Figure 4-2. Receiver, Overall Block Diagram

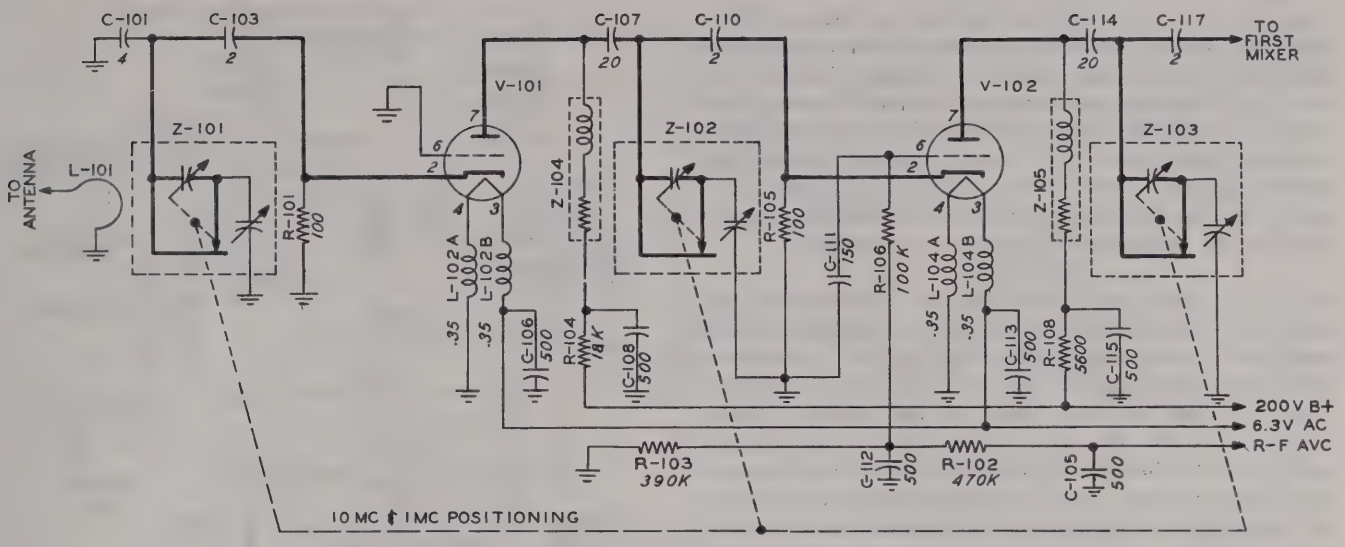


Figure 4-3. R-f Amplifier, Simplified Schematic

4-27. DETECTORS, NOISE LIMITERS, SQUELCH AND AVC CIRCUIT.

4-28. The third i-f signal is fed to the audio detector where the audio signal is detected and applied to the noise-limiter circuits to reduce the effect of impulse-type noise appearing in the signal. The avc detector and avc gate produce a d-c control signal which is applied to the various amplifier tubes in order to maintain a constant audio output level for wide variations in r-f input signal strength. The squelch circuit provides a d-c current to operate a carrier-operated relay which serves to remove an attenuator (QUIETING control) from the audio signal path whenever a carrier signal is received. In Radio Receivers R-278A/GR and R-278B/GR, a direction-finding circuit is provided whose 30-cps output bears a certain phase relationship to a reference signal generated in associated Radio Direction Finding equipment. This equipment (Radio Direction Finder AN/CRD-6) interprets the phase difference to disclose the direction of the signal source.

4-29. AUDIO AMPLIFIER.

4-30. The signal from the audio detector of the receiver is amplified by a three-stage audio amplifier. Two output circuits are provided; the main output (three watts into 600 ohms) appears at the PHONES jack and AUX CONTROL connector while the low level output (15 dbm) appears at the LOCAL CONTROL and AUX CONTROL connectors.

4-31. DETAILED THEORY OF OPERATION.

4-32. R-F SIGNAL INPUT.

4-33. The r-f signal is received at ANTENNA jack J1212 and is applied directly to the receiver section through jack J101 (on the r-f amplifier). In receivers R-278A/GR and R-278B/GR, low pass filter Z1202 is inserted in the path of the r-f signal for rejection of harmonic radiation effects.

4-34. R-F AMPLIFIER.

4-35. The r-f signal is link-coupled to the cathode of the first stage of a two-stage amplifier by way of loop L101 and tuned circuit Z101. (See figure 4-3.) The r-f amplifier consists of two grounded-grid, shunt-fed amplifiers and three identical r-f tuner circuits. The r-f tuners consist of a variable capacitor and a variable inductor that rotate simultaneously so that in 180° of rotation, the resonant frequency changes linearly 180 mc at the rate of 1.0 mc per degree of rotation. (See figure 4-4.) The variable capacitor portion

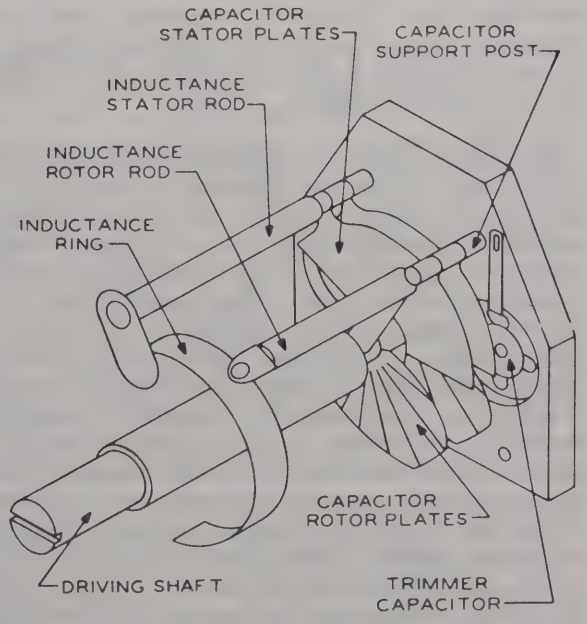


Figure 4-4. R-f Tuner, Pictorial Diagram

consists of three rotor plates and two stator plates. The two outside rotor plates are radially slotted for tracking purposes so that the resonant frequency of the tuned circuit can be made to change linearly with rotation. The variable inductance section consists of a stator inductance rod, a ring segment, and a rotor inductance rod. The three r-f tuners are geared together by the frequency selector differential arrangement of the 10-mc and 1.0-mc output shafts.

4-36. In receivers R-278/GR and R-278A/GR, avc voltage is impressed on the grid of amplifier V102 only, while in receiver R-278B/GR, avc voltage is applied to both amplifiers. (See figure 7-5.) Bifilar chokes in the filament leads and the inductive impedances of Z104 and Z105 in the plate shunt-fed circuits isolate the power supply circuits from radio-frequency voltages. The r-f signal is coupled from the r-f amplifier through a soldered connection to the first mixer located in the first i-f amplifier subassembly.

4-37. FIRST INJECTION SYSTEM.

4-38. The first injection frequencies are developed by the main oscillator and the frequency multiplier-amplifier. The main oscillator originates the first injection frequencies and the frequency multiplier-amplifier multiplies them either six or nine times so that injection frequencies are available at 10-mc intervals in the frequency range of 180 to 350 mc.

4-39. MAIN OSCILLATOR.

4-40. The main oscillator employs a Butler circuit which consists of oscillator V201, a bank of 18 crystal units with a crystal switch all contained within a temperature controlled oven, a bank of 18 coils with their associated selector switch, and other circuit elements. (See figure 4-5.) A Butler oscillator is essentially a zero-phase shift crystal oscillator employing a grounded-grid amplifier and a cathode-follower buffer feedback.

4-41. When voltage is applied to the plates of tubes V201A and V201B, the currents drawn by the two triodes are unequal due to the different plate load resistors. The difference in plate currents produce a difference in potential at the cathodes, thus applying a potential to the crystal. The crystal distorts under the difference in potential and relaxes when capacitor C207 charges. In relaxing, the crystal generates a voltage that causes a change in the cathode voltage of tube V201A. Assuming the relaxation voltage to the cathode to be positive, a rise in cathode voltage of a grounded-grid amplifier will cause the plate voltage to rise due to the reduction in tube current. The positive going excursion of the plate is coupled to the grid so that the positive pulse is coupled back to the cathode of the grounded-grid amplifier through the crystal. The series resonant crystal presents a low impedance path only at resonance. The oscillations are then maintained in the stage by the zero-phase feedback loop.

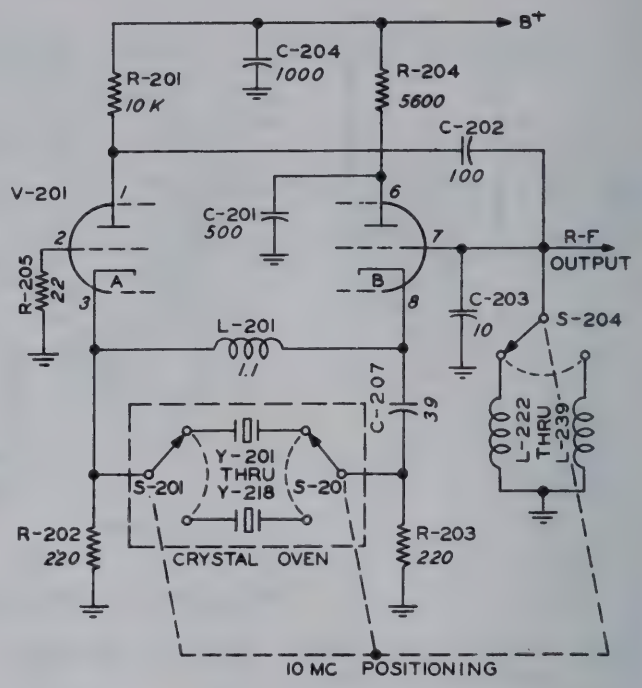


Figure 4-5. Main Oscillator, Simplified Schematic

The plate load of the grounded-grid amplifier is the tuned circuit consisting of capacitor C203 in parallel with the coil associated with the crystal being used. The frequency of oscillation can be adjusted over a small range by adjusting the tuning of the amplifier plate tuned circuit. Inductance L201 is used to resonate with stray circuit capacities at approximately 30 mc. The oscillator signal is fed to multiplier V301 through capacitor C301 and a soldered connection.

4-42. The oscillator crystals are maintained at a constant temperature by the thermostatically-controlled crystal oven. The crystal oven operates on 115 volts a-c and includes two heater elements and two thermostats. One heater element has a rating of approximately 100 watts and is employed to bring the oven to operating temperature rapidly when the equipment is first turned on. The second heater element has a rating of approximately 20 watts and operates intermittently to maintain the oven at the proper temperature (75 ∓ 5 degrees C).

4-43. FREQUENCY MULTIPLIER-AMPLIFIER.

4-44. The frequency multiplier-amplifier consists of two frequency multiplying stages, V301 and V302, three amplifying stages, V303, V304, and V305, and five interstage tuned coupling circuits Z301, Z303, Z305, Z307, and Z309. (See figure 4-6.) The first stage is either a doubler or a tripler depending upon the selected frequency. The second stage is a tripler and the last three stages are amplifiers. Tuned circuit Z301, in the plate circuit of the first stage, employs an 18-turn tapered toroidal coil. A rotary contact progressively adds turns of the coil as the frequency

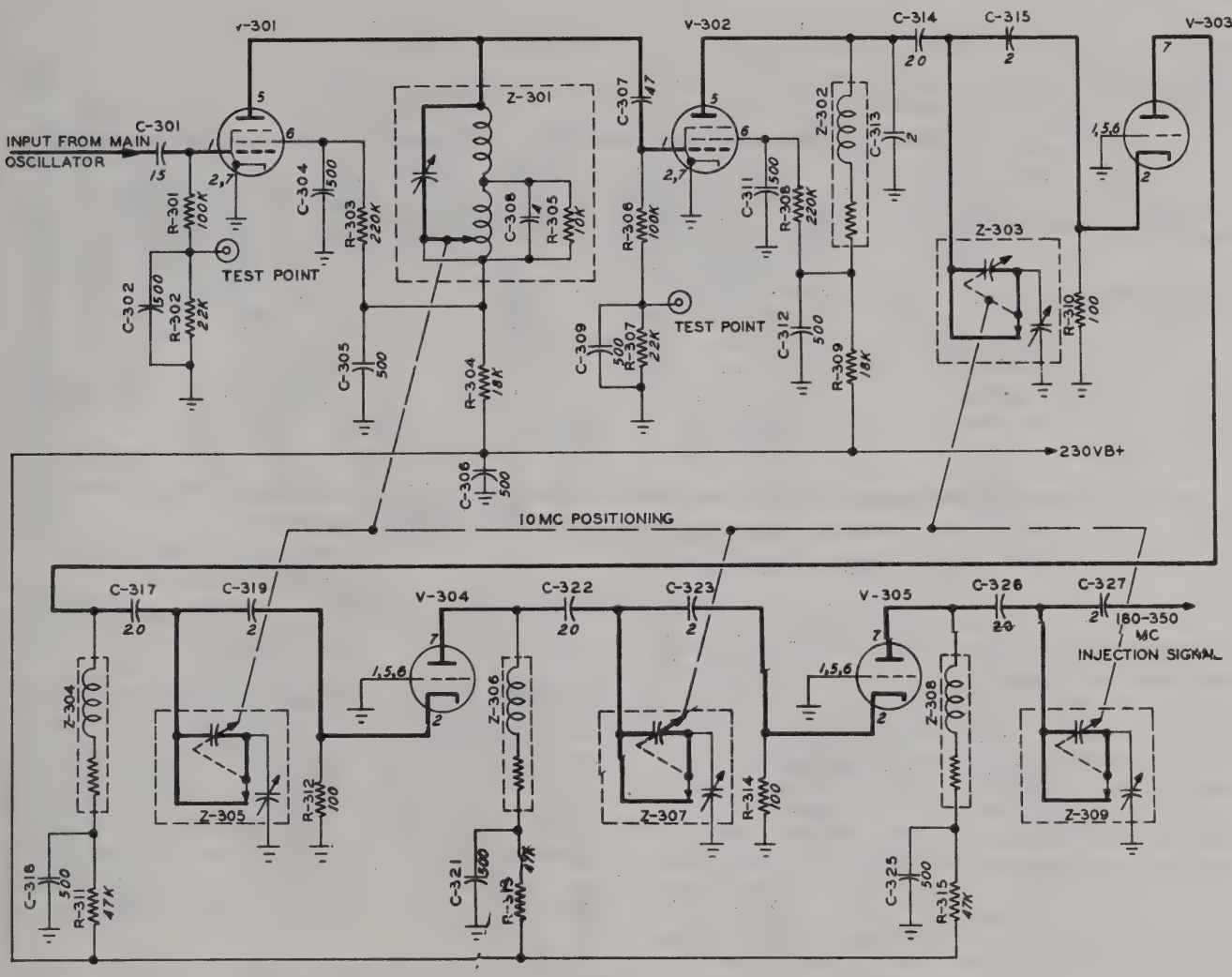


Figure 4-6. Frequency Multiplier-Amplifier, Simplified Schematic

decreases in ten-mc steps from the highest to the lowest frequency. This stage doubles the six lowest frequencies and triples the 12 highest frequencies generated by the main oscillator (26.67 to 38.89 mc). The signal is fed from the first stage to the grid of the second stage whose tuned plate circuit, Z303, is tuned to the third harmonic of that signal. The tuned circuit in the plate circuit of the second stage is similar to those described for the r-f amplifier in paragraph 4-35, except for the resonant frequency (180 to 350 mc). The output of the second multiplier is amplified by identical stages V303, V304, and V305 whose tuned plate circuits are also identical to that of multiplier V302. All tuned circuits in the frequency multiplier-amplifier are tuned by a geared output of the 10-mc output shaft of the frequency selector unit. The output of the frequency multiplier-amplifier (first injection system) is fed to the cathode of the first mixer, V401.

4-45. FIRST I-F AMPLIFIER.

4-46. The first i-f amplifier subassembly consists of the first mixer, V401, the first i-f amplifier, V402, two interstage transformers T401 and T402, the second mixer, V403, and the second injection system consisting of oscillator V404 and transformer T403. (See figure 4-7.) The first mixer combines the received r-f signal (225.0 to 399.9 mc) with the first injection signal (180.0 to 350.0 mc) to produce the first intermediate frequency (40.0 to 49.9 mc). The first i-f signal is amplified by first i-f amplifier V402 whose gain is controlled by the avc circuit. The amplified first i-f signal is applied to the second mixer grid where it is combined with the second injection signal (31.0 to 40.0 mc) to produce the second intermediate frequency (9.0 to 9.9 mc). This signal is applied to the grid of the second i-f amplifier.

4-47. Because the r-f channels are spaced at 0.1-mc intervals and the first injection frequencies are spaced at 10-mc intervals, there are 100 possible first intermediate frequencies. The first i-f interstage transformers, T401 and T402, are therefore made tunable in 100 steps of 0.1 mc each by means of a differential

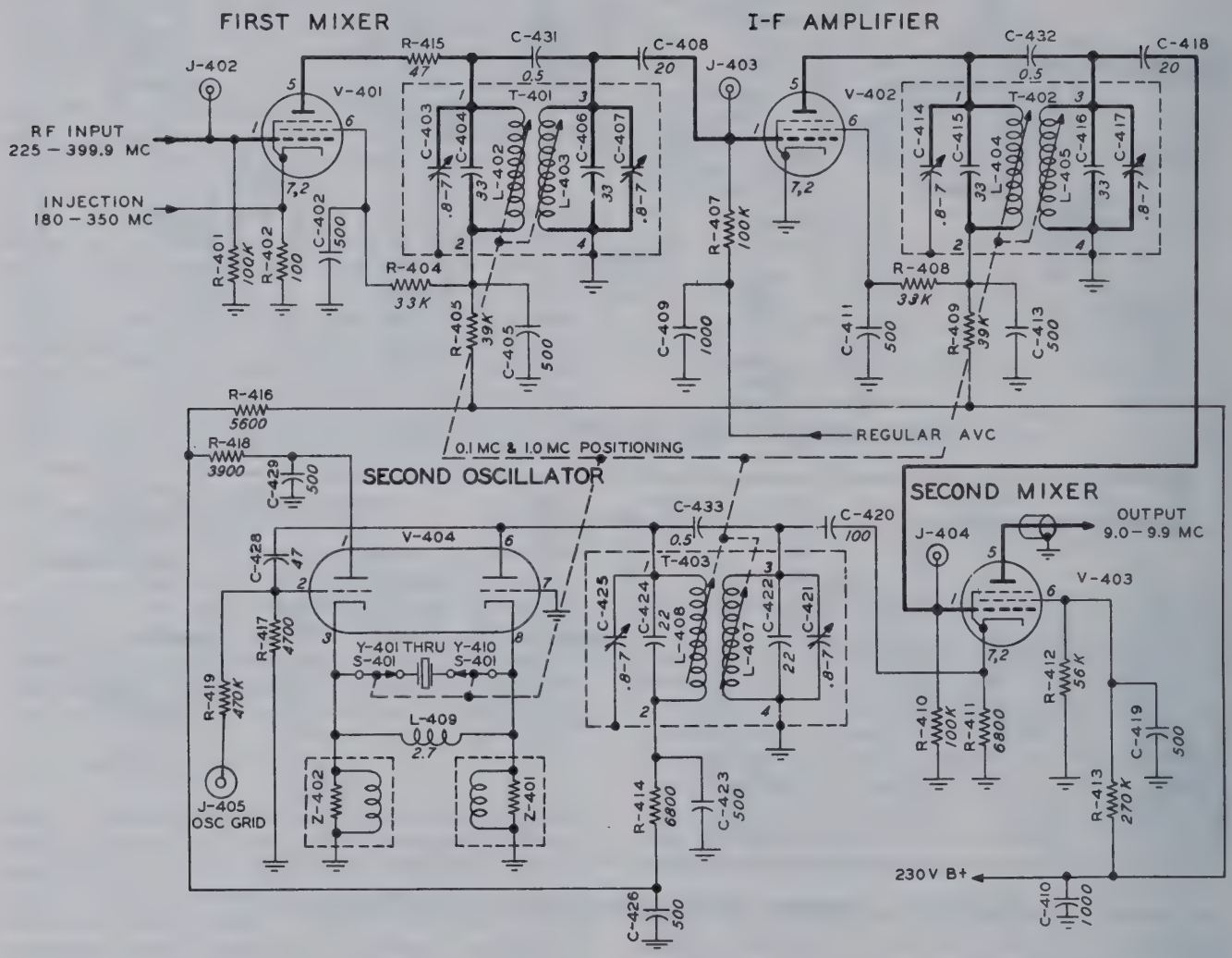


Figure 4-7. First I-f Amplifier, Simplified Schematic

mechanism, which includes a tuning rack that is cam-driven by the 0.1- and 1.0-mc output shafts. The interstage transformers are permeability-tuned by powered iron cores mounted on the rack. Cams on a fixed-bearing shaft driven by the 0.1-mc output shaft, raise or lower a floating shaft driven by the 1.0-mc output shaft which, in turn, raises or lowers the tuning rack. Since each set of cams adjusts the rack in 10 steps, the combination of the action of the two sets gives 100 positions of the tuning cores. Threaded studs on the cores make it possible to adjust each core independently when aligning. Trimmer capacitors across the tuned circuits are provided so that the most linear part of the tuning curve can be selected to give the best tracking.

4-48. The second injection system consists of a Butler-type oscillator circuit which employs one of 10 crystal units operating at frequencies from 31 to 40 mc. The theory of operation of a Butler oscillator circuit is explained in paragraphs 4-40 and 4-41. Selection of the correct crystal unit and tuning of the plate transformer is accomplished by the 1.0-mc output shaft, thus providing an injection frequency at each 1.0-mc interval between 31.0 to 40.0 mc. The second injection signal is fed to the cathode of the second mixer, V403.

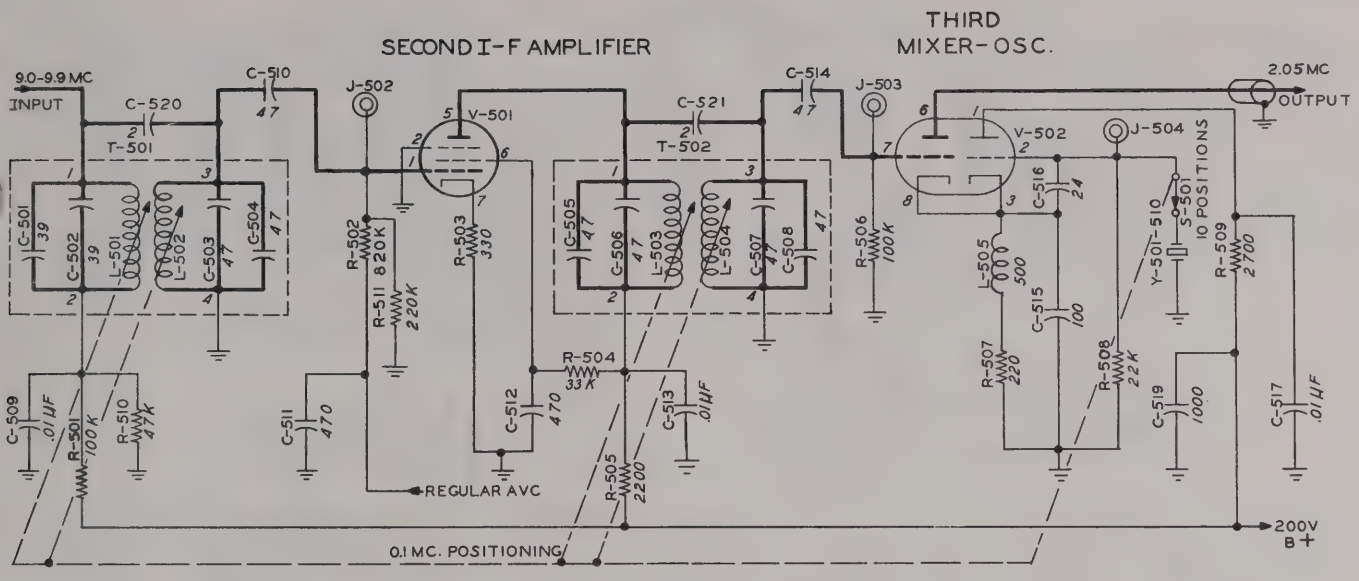


Figure 4-8. Second I-f Amplifier, Simplified Schematic

4-49. SECOND I-F AMPLIFIER.

4-50. The second i-f amplifier consists of amplifier V501 and oscillator-mixer V502. (See figure 4-8.) The second i-f signal (9.0 to 9.9 mc) is coupled from the plate of the second mixer through transformer T501 to the grid of amplifier V501. The amplified signal is then fed to the grid of the third mixer, V502A. Amplifier V501 is avc-controlled and the interstage transformers are permeability-tuned by a cam-driven tuning rack operated by the 0.1-mc output shaft.

4-51. Oscillator V502B is a Pierce-type oscillator used to generate the third injection signal in the frequency range of 6.95 to 7.85 mc. This signal is applied to the cathode of the third mixer, V502A. The correct crystal unit is selected by the 0.1-mc output shaft. The second i-f signal and the third injection frequency are heterodyned in mixer V502A to produce the third intermediate frequency of 2.05 mc. The output of the mixer is developed across the primary of transformer T601 in the third i-f amplifier.

4-52. THIRD I-F AMPLIFIER.

4-53. The third i-f amplifier subassembly consists of i-f amplifiers V601, V602, and V603, interstage transformers T601, T602, T603, and T604, audio detector V604A, avc detector V604B, direction finder detector V607B, audio and direction finder cathode followers V606A and B, noise limiters V605A and B, noise cancellation detector V608B, squelch circuit V608A and V609, and avc gate V607A.

4-54. Third i-f amplifiers V601 and V602 are avc-controlled, while amplifier V603 is cathode-biased. (See figure 4-9.) The four interstage transformers (T601-T604) are tuned to 2.05 mc. The bandwidth characteristics of the three i-f amplifiers are controlled through the coupling of these transformers. In receiver R-278/GR, the first three transformers are overcoupled and the last one is undercoupled. In receivers R-278A/GR and R-278B/GR, the first transformer is overcoupled and the last three are undercoupled. The output of i-f amplifier V603 is coupled through transformer T604 to the audio and avc detector circuits.

4-55. AUDIO DETECTOR AND NOISE LIMITING CIRCUITS.

4-56. The audio detector and noise limiting circuits consists of audio detector V604A, series noise limiter V605A, shunt noise limiter V605B, and a noise cancellation circuit using V608B. (See figure 4-10.)

4-57. The audio detector circuit is a conventional detection circuit utilizing diode detector V604A and its load resistors R613 and R614. The output of the detector is normally about -8 volts dc with respect to the cathode of the detector. A voltage divider network consisting of resistors R615 and R616 biases the cathode of the detector diode at approximately + 6 volts dc so that the potential from jack J604 to ground is -2 volts. The detected audio signal is superimposed on this bias voltage.

4-58. The series noise limiting circuit limits the audio output to approximately 40% of the modulating signal. Since impulse noise of the type encountered at uhf consists of very sharp pulses of several hundred percent modulation, this limiting action greatly reduces the amount of noise energy that would otherwise be applied to the audio amplifier, without adversely affecting the intelligibility of the voice signals.

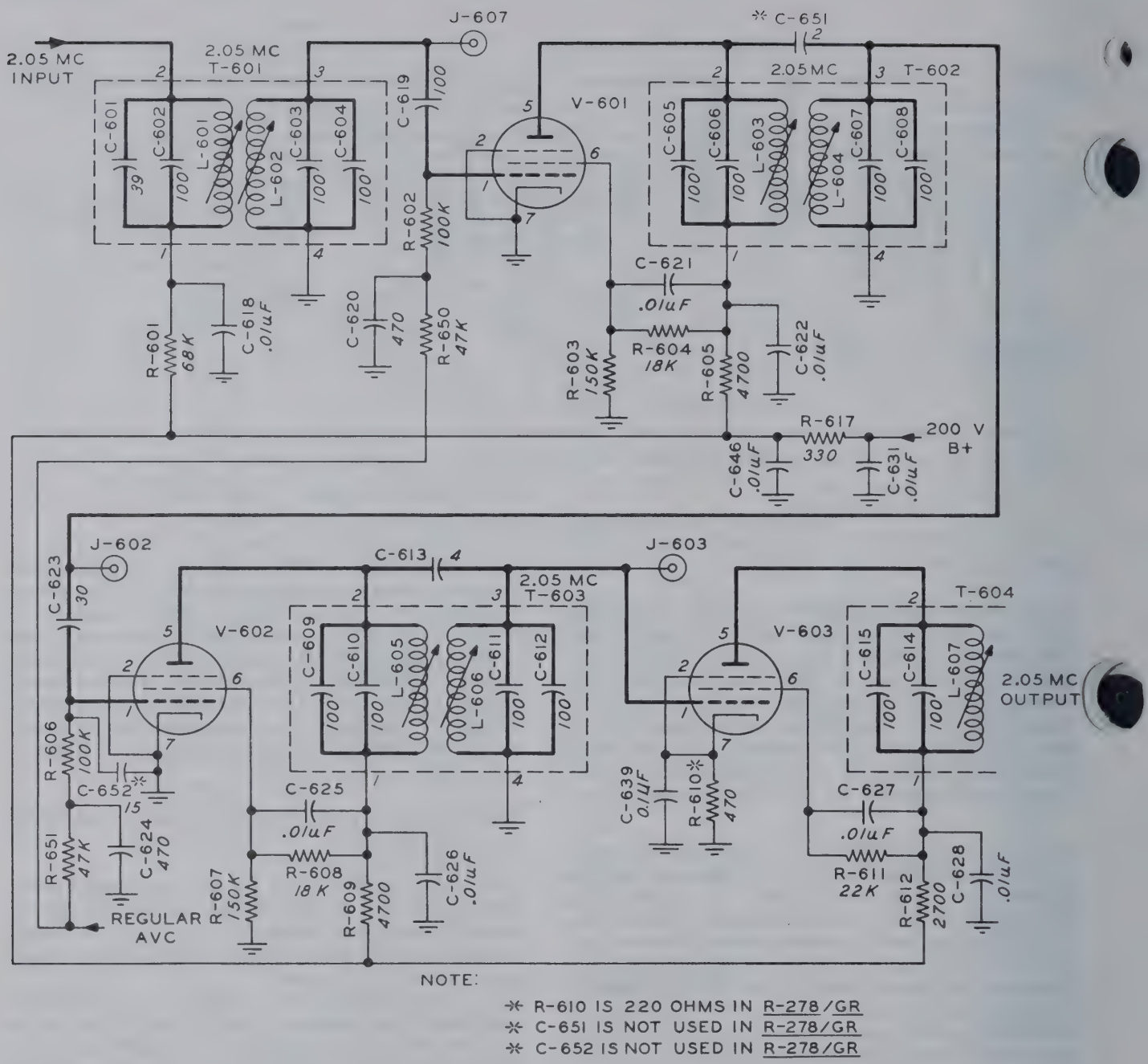


Figure 4-9. Third I-f Amplifier (Amplifier Section), Simplified Schematic

4-59. The circuit consists of series noise limiter V605A in series with resistors R622, R623, and R624, all of which are in parallel with audio detector load resistors R613 and R614. Capacitor C634B is connected from the junction of resistors R622 and R623 to ground. Without capacitor C634B in the circuit, the voltage distribution would be such that a small positive voltage would be applied to the plate of the diode with respect to the cathode, causing a small flow of current in the diode to electronically connect the plate and the cathode. Capacitor C634B causes the circuit to act as a filter and produce a bias at the cathode of the diode equal to the average level of the audio signal. The time constant of the combination of capacitor C634B and resistor R622 is such that the bias voltage developed limits the audio output of the series noise limiter to 40% of the modulating signal. Whan a noise signal is applied to the series noise limiter circuit, the filter network holds the cathode of the diode at the average audio voltage level, while the plate of the diode is driven negative with respect to the cathode. The diode does not conduct until the noise signal is passed (plate is again more positive than the cathode). Since the audio output is taken from the cathode of series noise

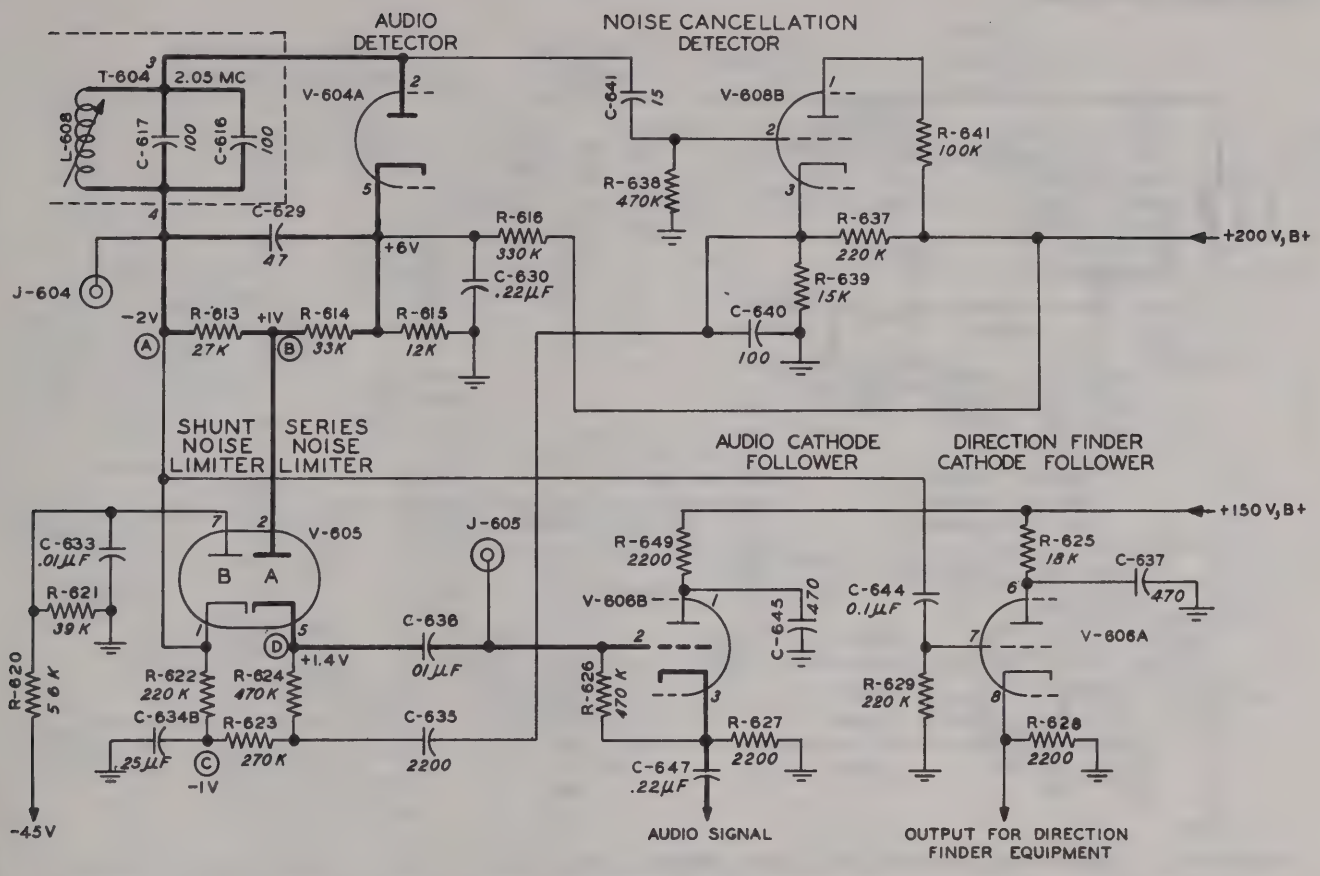


Figure 4-10. Receiver R-278/GR, Audio Detector, Noise Limiter and Direction Finder Circuits, Simplified Schematic

limiter V605A, the noise impulse is not applied to the audio amplifier.

4-60. The amount of noise energy remaining in the output of the series noise limiter circuit is further reduced by the introduction of noise pulses of about equal amplitude but of opposite polarity to cause noise cancellation. These pulses are generated by noise cancellation detector V608B. This tube operates as an infinite-impedance type detector in which the i-f signal is applied to the grid of the tube and the detected output appears at the cathode. In this application, the tube is cathode-biased (by means of voltage divider R637 and R639) at a level which permits only those signals exceeding 100% modulation to be detected. Noise pulses which appear as positive pulses in the cathode circuit are coupled back into the output of the series noise limiter circuit by capacitor C635.

4-61. A shunt-type limiter is also included in this receiver for the purpose of protecting the avc and squelch circuits from the effects of noise pulses. In this circuit, diode V605B is biased by means of voltage divider R620 and R621. When an i-f signal whose peak amplitude is greater than this bias is applied to the circuit, the diode conducts and effectively clamps the signal at the bias level. This reduces the effect of noise impulses which ordinarily would generate appreciable avc voltage and reduce the sensitivity of the receiver. The shunt noise limiter also reduces the tendency of the squelch circuit to open in the presence of noise impulses.

4-62. AUDIO CATHODE FOLLOWER.

4-63. The audio output of the noise limiter circuit is coupled to the grid of audio cathode follower V606B through capacitor C636. (See figure 4-10.) The output of this stage is developed across cathode resistor R627 and is transmitted through shielded wire to the QUIETING and FREQUENCY RESPONSE controls.

4-64. DIRECTION FINDER CATHODE FOLLOWER.

4-65. Radio Receiver R-278/GR employs a direction finder circuit, but the output signal does not meet the requirements of the direction finding system. Receivers R-278A/GR and R-278B/GR are used in a direction finding system, particularly with Radio Direction Finder AN/CRD-6. In this system, a receiving antenna rotating at 1800 rpm causes 30-cps modulation of the incoming r-f signal. The 30-cps output of the direction finder cathode follower bears a certain phase relationship with reference generated in Radio Direction Finder AN/CRD-6 which is interpreted to disclose the direction of the source signal.

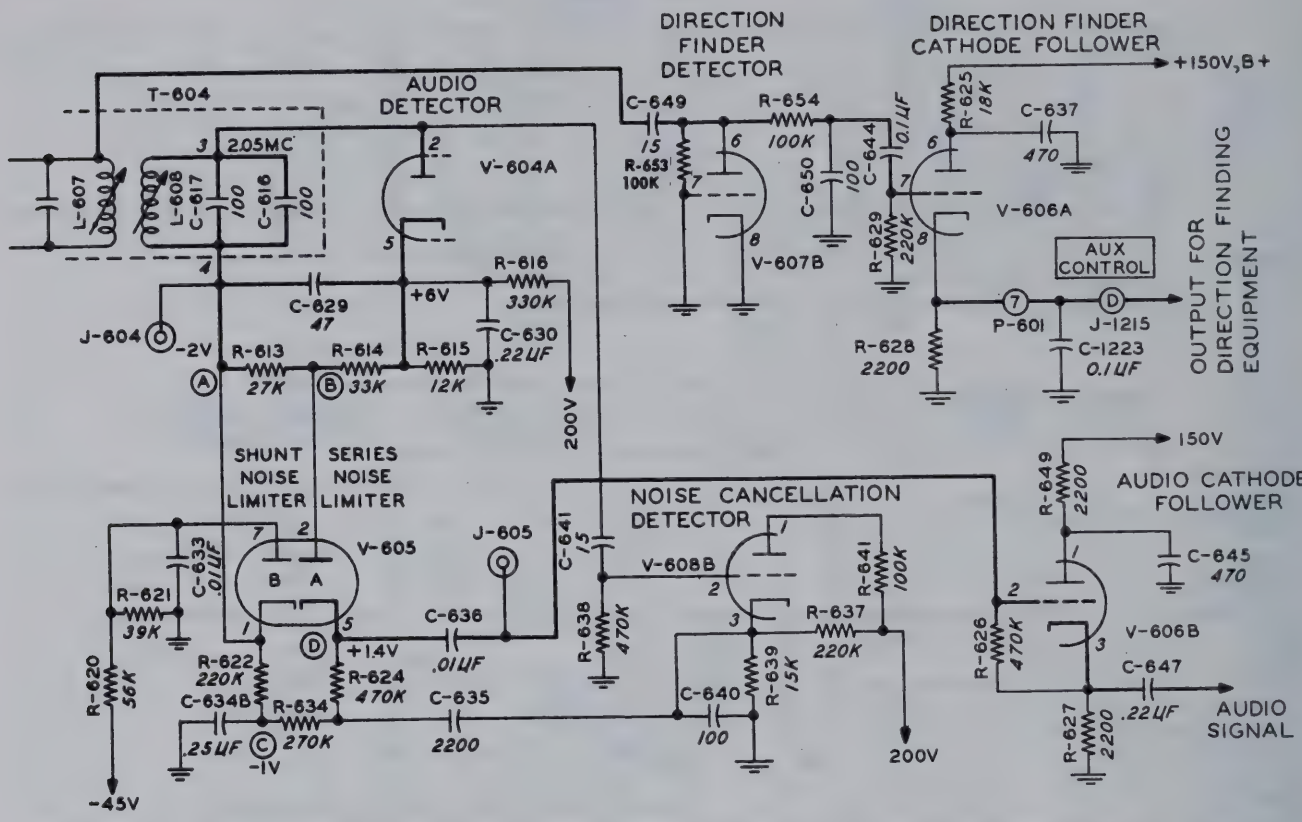


Figure 4-11. Receivers R-278A(B)/GR, Audio Detector, Noise Limiter and Direction Finder Circuits, Simplified Schematic

4-66. The direction finder circuit of the R-278/GR, although not used, is described here briefly for reference purposes. (See figure 4-10.) The audio signal, developed by the audio detector circuit, is coupled to the grid of cathode follower V606A by capacitor C644. The output of this stage is developed across cathode resistor R628 and fed to pin D of AUX CONTROL connector J1215. In receivers R278A/GR and R-278B/GR, the third i-f signal is detected by direction finder detector V607B. (See figure 4-11.) The audio signal developed by this detector is coupled to the grid of cathode follower V606A by capacitor C644. The output of this cathode follower stage is developed across cathode resistor R628 and is fed to pin D of AUX CONTROL connector J1215.

4-67. AVC DETECTOR AND AVC GATE.

4-68. The avc circuit includes the avc detector V604 and avc gate V607A. (See figure 4-12.) Three controls on the front panel are associated with the avc circuit; AVC TIME CONSTANT switch S1204, MAIN RF GAIN control R1207 (RF GAIN on R-278B/GR), and AVC switch S1202. (In receivers R-278A/GR and R-278B/GR, switch S1202 is labelled RF GAIN.) The avc detector maintains the output of the receiver relatively constant for wide variations of signal input level. The purpose of the avc gate is to provide an avc voltage delay so that the weak signals will be able to come through with maximum amplification.

4-69. Diode detector V604 and its associated components form a voltage doubler circuit for the avc voltage. (See figure 4-12.) A positive voltage is tapped off from a voltage divider consisting of resistors R615 and R616 and applied to the cathode of avc gate V607A. This voltage, in conjunction with a negative bias applied to the grid of avc gate V607A by means of voltage divider R631 and R632, is sufficient to keep the tube cut off for low values of carrier signal strength. As the carrier level increases in audio detector V604A, the negative voltage developed across its load, R613 and R614, also increases. At the same time, avc detector V604B develops an increasing negative voltage across its load resistor R618. Since these two sections of the diode conduct on opposite halves of the cycle, the voltages developed across their respective loads are in series of additive. The combined voltage appears at the plate of diode V604B and at the cathode of avc gate V607A. The cathode voltage of avc gate V607A continues moving in a negative direction with increases in amplitude of the r-f input signal until the grid is no longer sufficiently negative with respect to the cathode to maintain the tube in its cut-off condition. The avc gate then conducts and develops a negative voltage, which is applied to the avc circuits. Stronger r-f carrier signals produce greater ave voltages, thereby reducing the gain of the receiver proportionately. The gain of the r-f and i-f amplifiers is determined by the setting of MAIN RF GAIN control R1207. AVC TIME CONSTANT switch S1204 has two positions; COMM

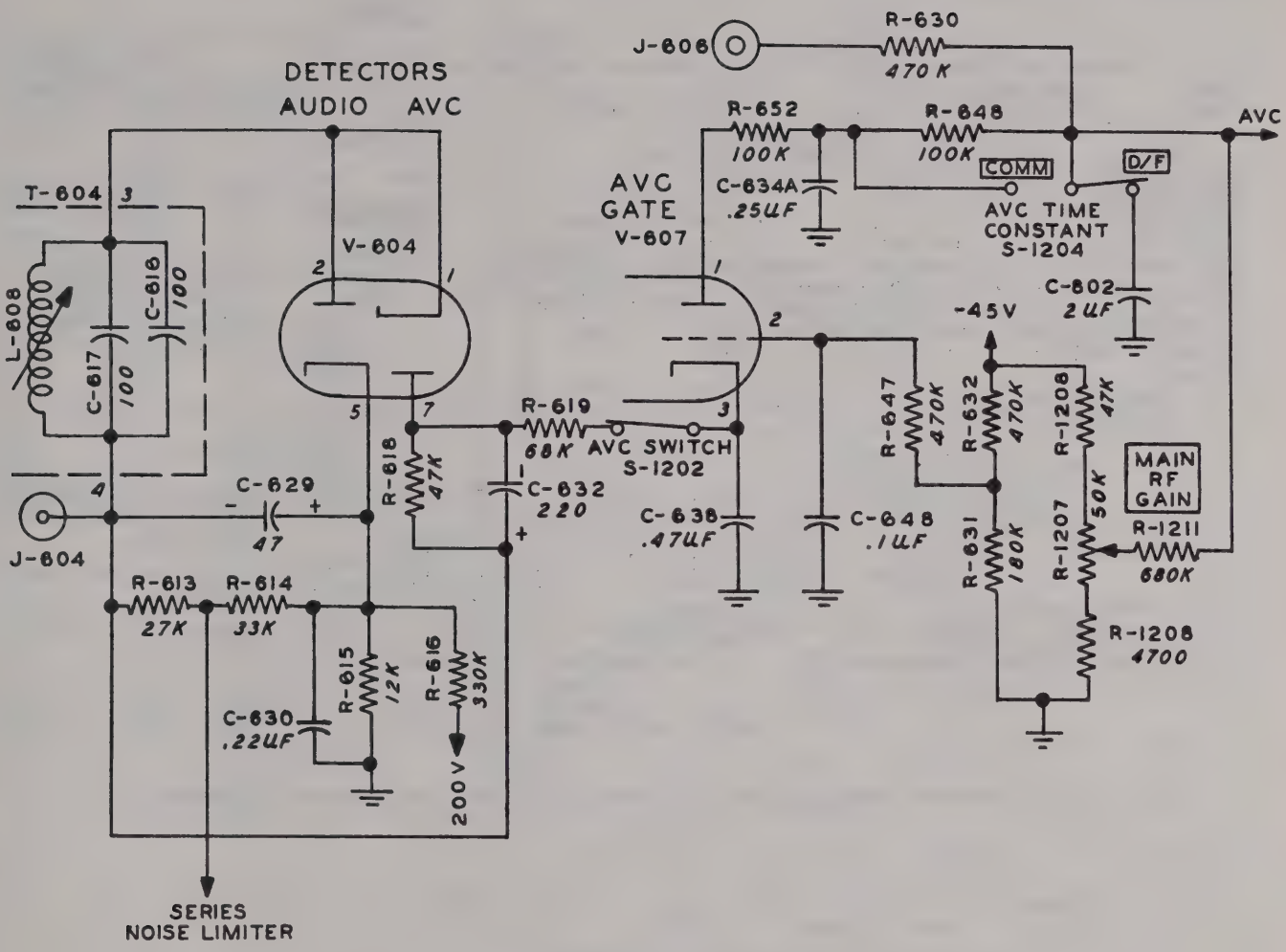


Figure 4-12. Receiver R-278/GR, AVC Detector and AVC Gate, Simplified Schematic

(communications) and DF (direction finder). These positions provide time constants for avc operation of 0.1 and 1.0 second (approximate), respectively. A set of contacts of muting relay K802 grounds the avc voltage when the receiver is not in operation. (See figure 7-1.)

4-70. In receivers R-278A/GR and R-278B/GR, a remote r-f gain control may be used by connecting a potentiometer from pin J of the AUX CONTROL connector to ground. The recommended value of this potentiometer is 25,000 ohms. (See figure 4-13.)

4-71. CARRIER-OPERATED RELAY AND SQUELCH CIRCUIT.

4-72. The receiver is provided with a carrier-operated relay, K801, which is actuated by a two-stage, d-c amplifier consisting of V608A and V609, that receives its control signal from the audio detector circuit. (See figure 4-14.) The circuits are designed so that the relay will be actuated whenever a carrier signal of sufficient amplitude (as determined by the MAIN RF GAIN control setting) is received. The carrier-operated relay is provided with three sets of contacts used to perform the following functions: operate external equipment, MAIN CARRIER indicator lamp I1203 and the audio squelch (silencing circuit). The controls associated with the carrier-operated relay circuit are SQUELCH switch S1205 and QUIETING CONTROL R1204, both of which are located on the front panel.

4-73. The two stages of the squelch circuit operate as a one-shot multivibrator which is triggered by a negative voltage level taken from the audio detector circuit. The audio component of the negative voltage is by-passed by capacitor C642. When there is no signal, audio detector V604A does not conduct and no negative bias voltage is developed across its load. The positive bias from bleeder resistors R615 and R616 is then applied to the grid of tube V608A, the first stage of the squelch circuit. Tube V608A conducts, producing a voltage across resistor R644 which drives the grid of tube V609 negative with respect to its cathode. The bias voltage applied to the grid of tube V609 causes the tube to be cut off. When a carrier is received, the negative voltage developed by the audio detector circuit

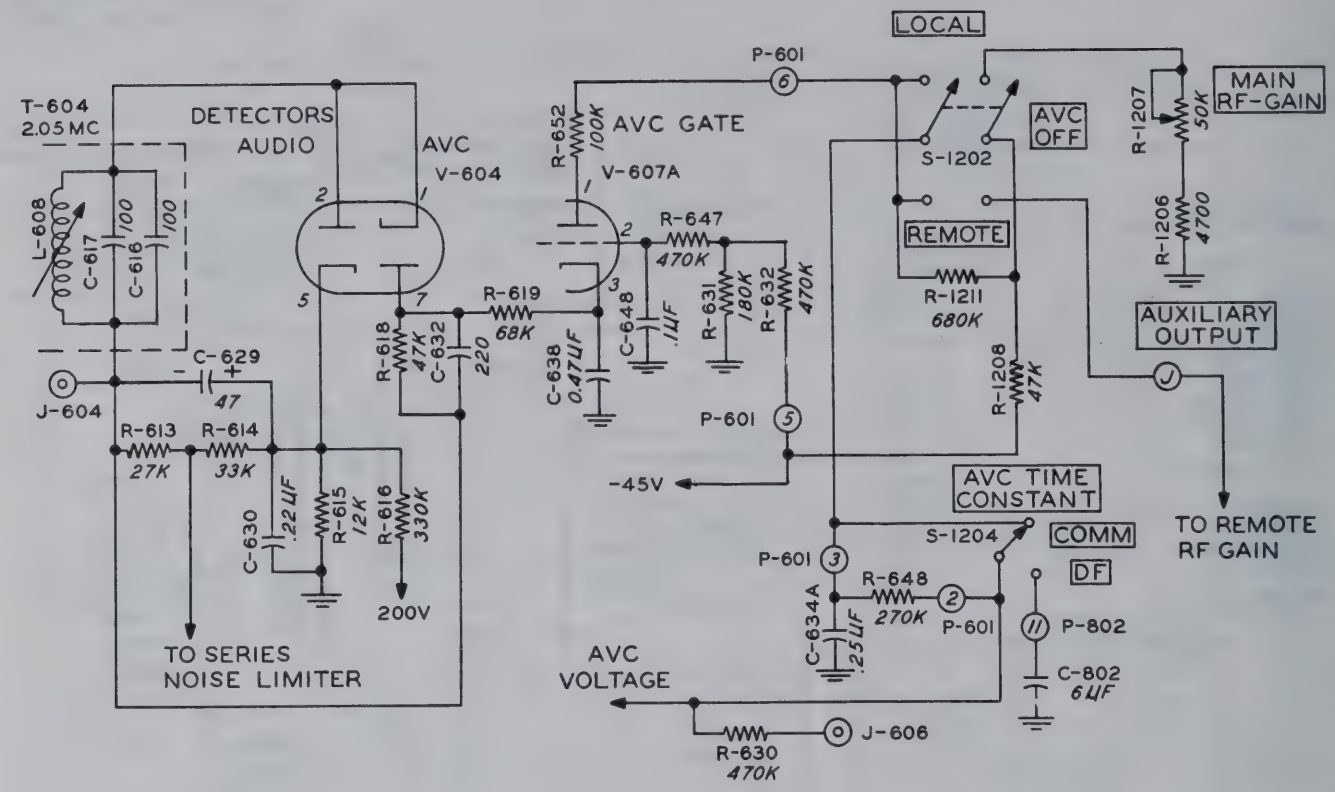


Figure 4-13. Receivers R-278A(B)/GR, AVC Detector and AVC Gate, Simplified Schematic

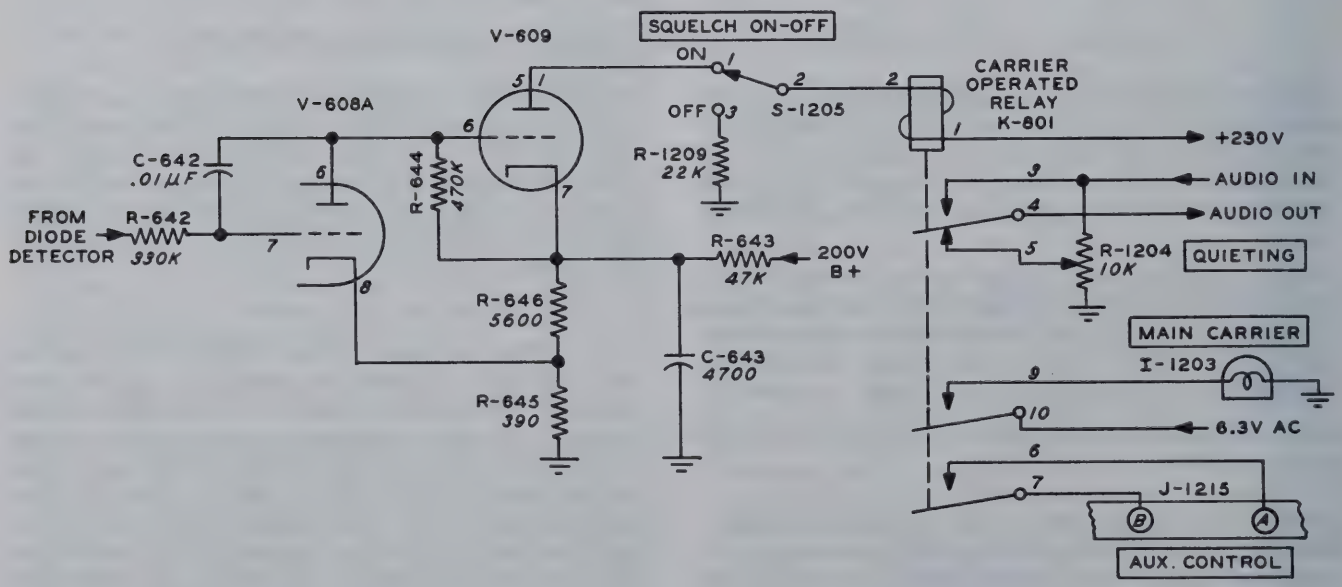


Figure 4-14. Carrier-Operated Relay and Squelch Circuit, Simplified Schematic

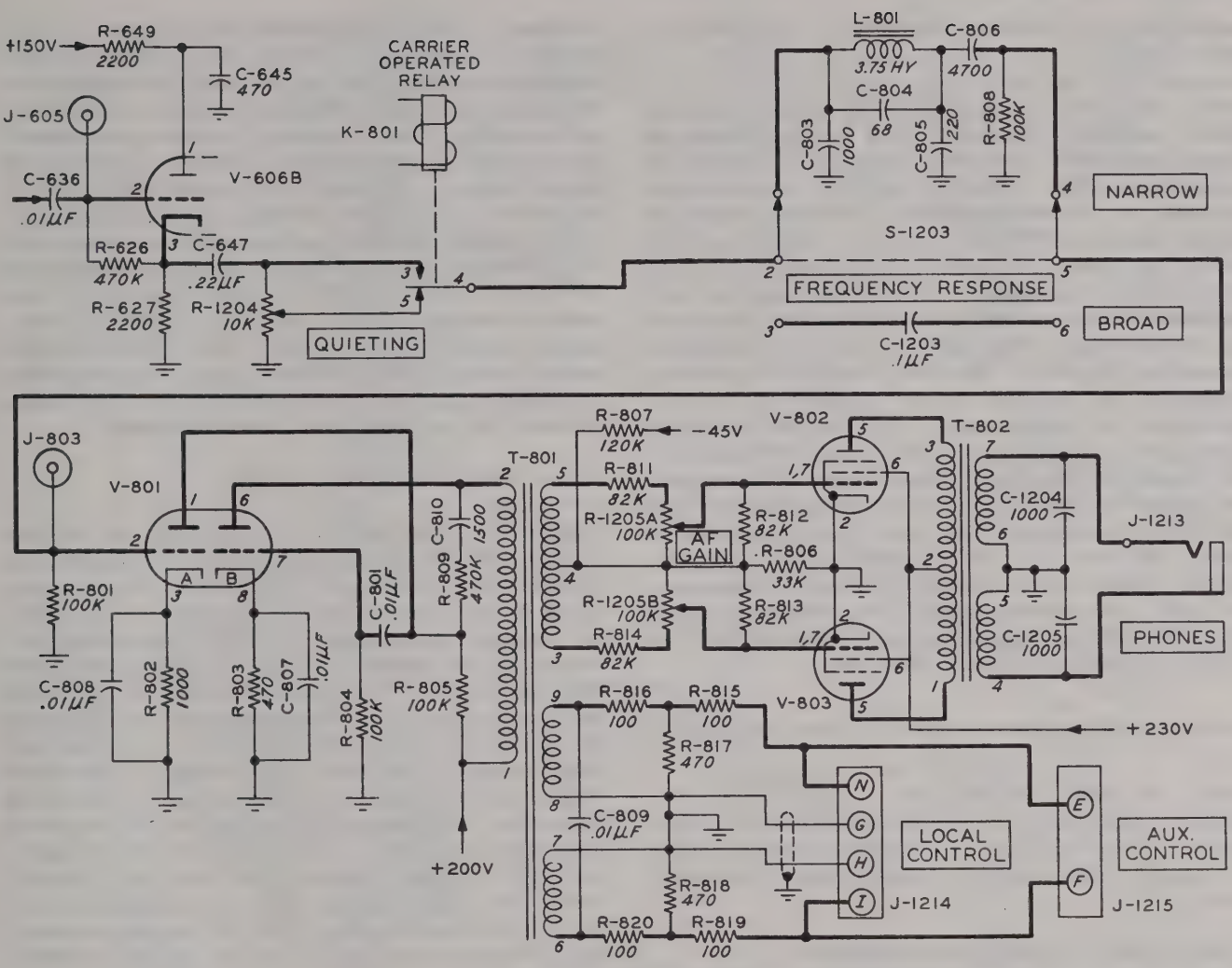


Figure 4-15. Audio Amplifier and Associated Controls, Simplified Schematic

is applied to the grid of tube V608A, causing a reduction in plate current. The reduction in current in tube V608A allows the voltage on the grid of tube V609 to become less negative, causing tube V609 to conduct. The current flow through tube V609 causes a voltage drop across resistor R645, thereby increasing the bias on tube V608A. This action is regenerative and causes tube V608A to be cut off quickly while the current through tube V609 increases sufficiently to energize carrier-operated relay K801.

4-74. The carrier-operated relay, when energized, operates the MAIN CARRIER indicator lamp, removes the QUIETING control from the audio amplifier circuit, and provides a set of contacts for the operation of external equipment through pins A and B on AUX OUTPUT connector J1215. With SQUELCH switch S1205 in the ON position, the operation of the carrier-operated relay is as described in paragraph 4-73. In the OFF position, the carrier-operated relay remains energized at all times.

4-75. AUDIO AMPLIFIER.

4-76. The audio amplifier consists of amplifiers V801, V802, and V803. The front panel controls associated with the audio amplifier are QUIETING control R1204, FREQ. RESPONSE switch S1203 and AUDIO GAIN control R1205. (See figure 4-15.) The audio signal developed across resistor R627 in the cathode circuit of audio cathode follower V606B (in the third i-f amplifier) is coupled through capacitor C647 to the QUIETING control. When no signal is present, the carrier-operated relay is deenergized and contacts 4 and 5 of the relay are closed, completing a circuit to the wiper arm of QUIETING control R1204. In this position, the receiver noise output can be attenuated any desired amount. When an r-f signal is received, relay K801 energizes and contacts 3 and 4 close, bypassing the QUIETING control. Before application to the audio amplifier, the audio signal is fed through FREQ. RESPONSE switch S1203. This switch has two positions; BROAD and NARROW. In the BROAD position, capacitor C1203 is in the circuit and the characteristic flat response of the receiver (from 200 to 20,000 cps) is employed. In receiver R-278B/GR a direct connection is made. In the NARROW position, an audio filter is switched into the circuit so that the

audio frequency response is limited to a narrowband. (See Table V.)

4-77. The audio signal is amplified by the two-stage audio amplifier V801 and applied to the primary of transformer T801. Two of the secondary windings of transformer T801 furnish a low-level output for the operation of external equipment. This output appears at the LOCAL CONTROL and AUX CONTROL output jacks, pin N and I of jack J1214 and pins E and F of jack J1215, respectively. These two windings are ordinarily connected in series, with their junction point grounded. These windings may also be individually connected to ground. The latter arrangement is provided for use with the "double simplex technique," in which a d-c control signal is carried over the same lines that are used for the audio signal. The remaining secondary winding of transformer T801 couples the signal through AUDIO GAIN control R1205 to the grids of the push-pull amplifier stage consisting of tubes V802 and V803. The output of the push-pull amplifier is fed to PHONES jack J1213 through transformer T802. A maximum of three watts output is available at the PHONES jack and at pin G and H of the AUX CONTROL on R-278A/GR and R-278B/GR.

4-78. POWER SUPPLY AND CONTROL CIRCUITS.

4-79. The self-contained power supply of Radio Receivers R-278/GR, R-278A/GR, and R-278B/GR supplies filament and high-voltage power to the receiver section, the audio amplifier, and the frequency selector unit.

4-80. POWER SUPPLY RECTIFIER.

4-81. The power supply rectifier consists of tubes V901, V902, and V903, and operates in conjunction with transformer T901 to provide the plate voltage supply, relay voltage, and bias voltage. (See figure 4-16.) Transformer T902 provides the filament voltage for all circuits, including the power supply rectifiers. The receiver is energized by connecting power jack J1216 to a source of 115- or 230-volt, 50- to 60-cycle power and turning on the POWER switch S1201. The plate and filament transformers T901 and T902 employ dual winding primaries which are connected so that either 115- or 230-volt operation may be selected by operating switches S901 and S902, located on the power supply rectifier unit. When POWER switch S1201 is turned on, filament transformer T902 is instantly energized through fuse F1202. A time delay of approximately 30 seconds, provided by thermal relay K901, permits the rectifier filaments to reach operating temperature before the plate transformer is energized to apply plate voltage.

4-82. The rectifier section that employs tube V902, a gas-filled type rectifier tube, is a full-wave circuit which provides 115 volts dc for the operation of muting relay K802, and the various relays associated with the frequency selector mechanism. This section is connected in series with the full-wave rectifier section which employs the V901 to provide the plate supply for the operation of the receiver circuits. A third full-wave rectifier, V903, operates from the same secondary winding as tube V902 to provide a negative bias supply voltage. Filament transformer T902 is provided with a 12.6-volt secondary winding which provides filament voltage for the receiver, and two 2.5-volt secondary windings which supply filament voltage for tubes V901 and V902. In order to provide a 115-volt a-c supply for the operation of thermal time-delay relay K901, blower motor B1201, frequency selector motor B1101, and the heater elements of the receiver crystal oven, the primary section of transformer T101 is wound as an autotransformer.

4-83. POWER SUPPLY FILTER.

4-84. The power supply filter is built up in three sections; the 230-volt section, the 200-volt section, and the bias supply section. The 230-volt section is a choke-input L-section filter. The input choke, L1001, is resonated with capacitor C1001 at the second harmonic of the power frequency to supply additional filtering action. The 230-volt output of this filter section is routed through the normally-closed contacts of the muting relay, K802, and back to the 200-volt filter section of the power supply filter, where additional filtering occurs and the voltage is reduced to 200 volts. The bias supply filter section is a resistor-capacitor filter, the output of which is approximately -45 volts. Voltage regulator tube V804, which is located in the audio amplifier unit, may be considered as part of the power supply. This tube supplies a regulated 150-volt plate supply for the cathode follower circuits.

4-85. POWER SUPPLY SYSTEM VOLTAGE OUTPUTS.

4-86. Distribution of the eight voltage outputs is as follows:

a. 230 volts dc. Plate voltage for the audio output tubes, squelch output tube, r-f injection amplifiers, and the third i-f amplifiers.

b. 200 volts dc. Plate voltage for the r-f amplifiers, the first i-f amplifier unit, the second i-f amplifier unit, and the first audio amplifier, V801.

c. 150 volts dc. Plate voltage for the audio and direction finder cathode followers.

d. 115 volts dc. Relay supply and frequency selector unit control circuits.

e. -45 volts dc. Bias for the audio amplifiers, bleeders for the r-f gain controls, bleeders for avc gates and shunt noise limiters.

f. 115 volts ac. Main oscillator crystal oven heater,

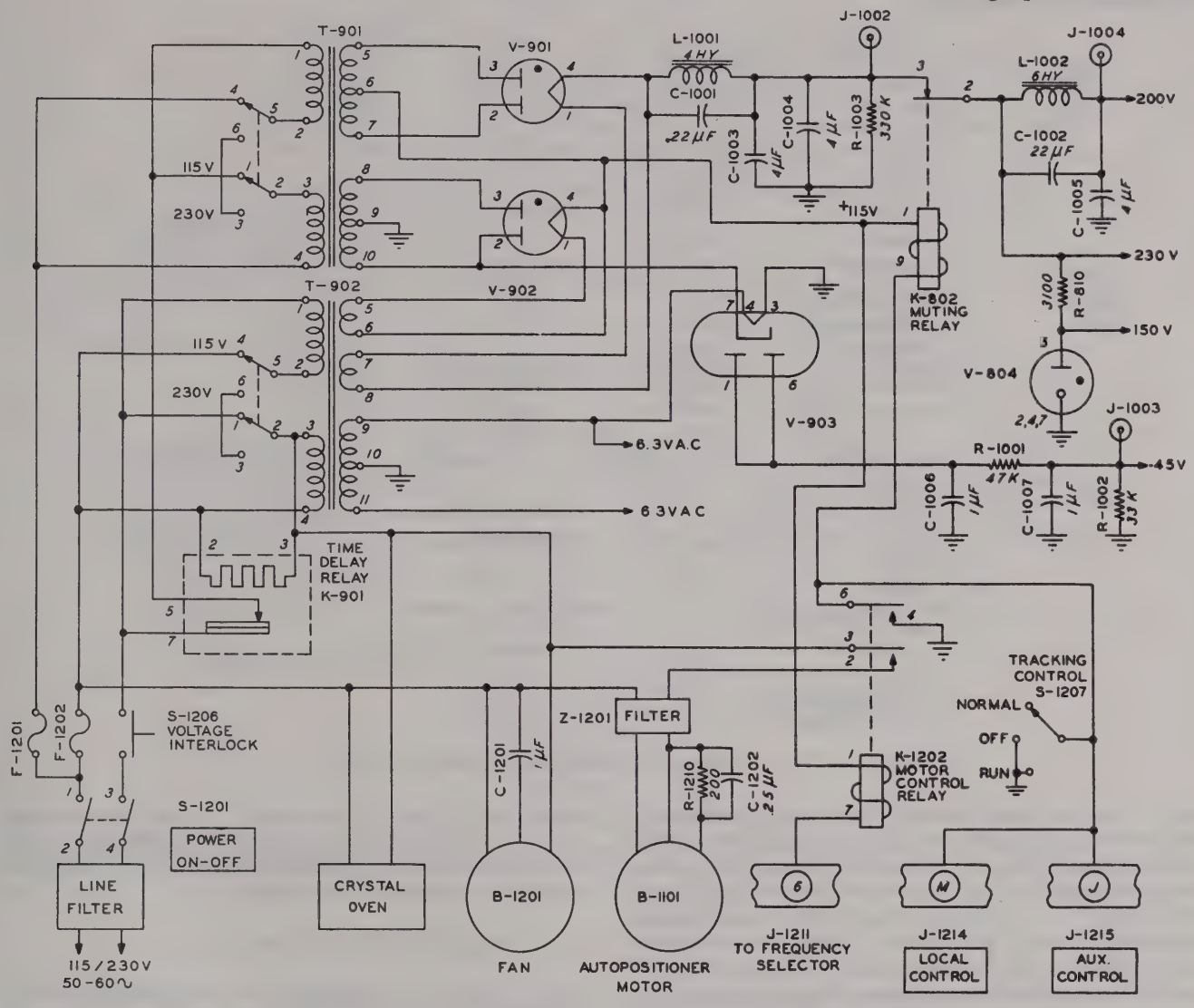


Figure 4-16. Power Supply and Control Circuits, Simplified Schematic

frequency selector motor and fan motor, and thermal time-delay relay.

g. 6.3 volts ac. Filament voltage for the third i-f amplifier unit.

h. 6.3 volts ac. Filament voltage to all other units.

4-87. The receiver is provided with a muting relay, K802, whose principal function is to silence the receiver at the time that the Radio Transmitter T-217A/GR carrier is on. (See figure 4-16.) The relay is operated on 115 volts dc and is actuated by providing a ground connection to the relay coil. The muting relay can be energized from an external source by grounding pin M of jack J1214 or pin J of jack J1215, and is automatically energized whenever the frequency selector mechanism operates or whenever the tracking control switch, S1207, is set to OFF or RUN. The muting relay interrupts all receiver plate voltages.

4-88. FREQUENCY SELECTOR.

4-89. GENERAL.

4-90. The frequency selector unit contains a channel selector switch, a motor, a preset panel, a channel and frequency indicator panel, four autopositioner units and their associated seeking switches, and various channel energizing switches. (See figure 4-17.) Operation of the unit is as follows. When the position of the channel selector switch is changed, the channel autopositioner energizes through the local channel seeking switch. The channel autopositioner energizes the motor which, in turn, drives the channel autopositioner along with the seeking switches and channel energizing switches coupled to it. When the channel seeking switch reaches the position which corresponds to the selected channel, it deenergizes the channel autopositioner. The channel energizing switches, which are now set to a new position, energize the 10-mc, 1.0-mc,

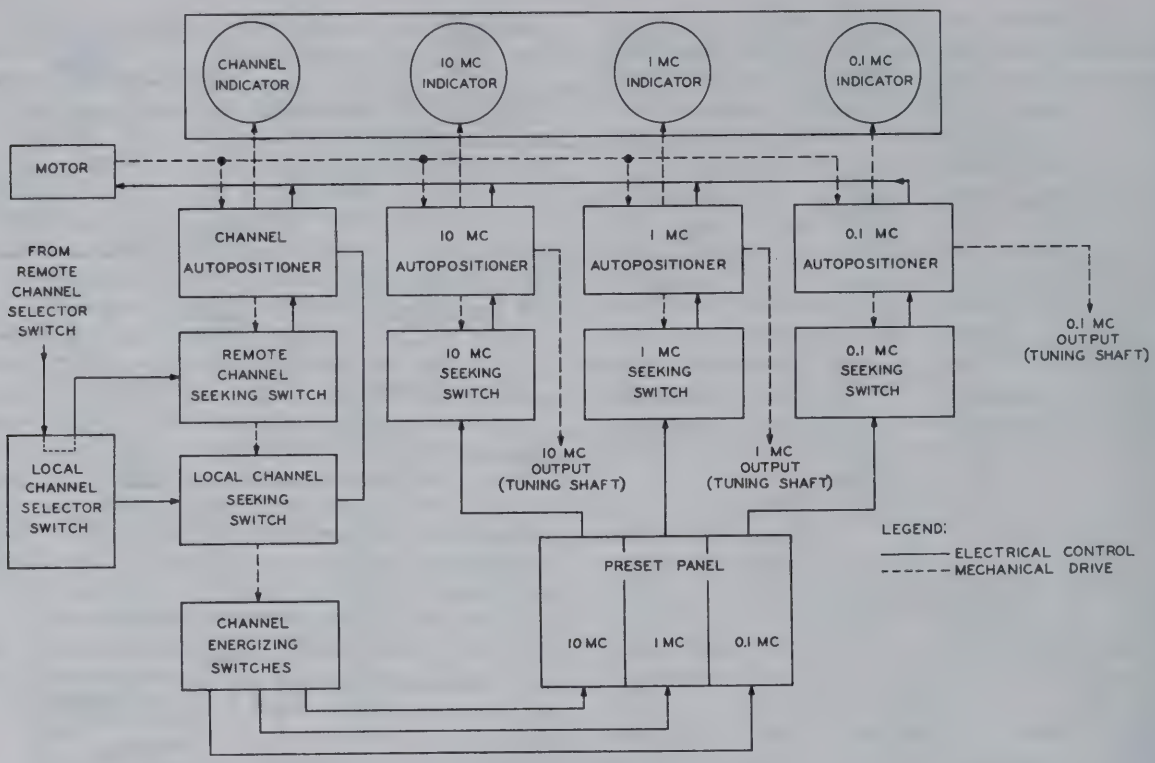


Figure 4-17. Frequency Selector Unit, Block Diagram

and 0.1-mc autopositioners through the preset panel. The motor is no longer energized through the channel autopositioner, but is now energized through the other autopositioners. The motor now drives these autopositioners and their associated seeking switches. Operation of the 10-mc, 1.0-mc, and 0.1-mc autopositioners causes their corresponding output shafts to rotate to that position which properly tunes the receiver. When the seeking switches reach the position corresponding to the channel frequency selected at the preset panel, the autopositioners and the motor are deenergized, thus completing the frequency selecting cycle. The new channel operating frequency can be observed on the channel and frequency indicators which were positioned during the operation of the various autopositioners. Operation of the frequency selector unit is the same for remote frequency selection with the exception that the channel autopositioner is initially energized through the remote channel seeking switch instead of the local channel seeking switch.

4-91. Any 11 of the 1750 possible operating frequencies of the receiver may be preset for automatic selection by the use of the preset panel. This panel employs a bank of 33 rotary-type switches. These switches are arranged in three banks of 11 switches each, with their corresponding stator contacts connected in parallel. The 10-mc frequency is set up on the first bank, the 1.0-mc frequency on the second bank, and the 0.1-mc frequency on the third bank of preset switches. The 11 preset channels are set up by combining the settings of the three switches associated with each of the 11 channels. Ten of the 11 preset channels may be selected from a remote location, while the eleventh or MANUAL channel may be selected only at the receiver front panel.

4-92. AUTOPOSITIONER UNIT.

4-93. The basic elements of the autopositioner are a motor and its gear reduction, a slip clutch, a notched stop-wheel which is fastened to a rotory shaft, a pawl which engages the notches of the stop-wheel, a relay which actuates the pawl, and a motor start relay which operates a set of electrical contacts to start and stop the motor. (See figure 4-18.) Associated with each autopositioner is an electrical control system consisting of a remote control switch and a corresponding seeking switch which is driven by the autopositioner shaft. This control system is designed so that whenever the remote control switch and the seeking switch are not set to the same electrical position, the autopositioner unit is energized and operates to drive its shaft (and the driven elements to which it is coupled) to the proper position to restore the symmetry of the control system.

4-94. Operation of the autopositioner unit is as follows. The unit is at rest when the remote control switches are in corresponding positions (open circuit), the relays and the motor are deenergized, and the pawl is engaging a stop-wheel notch. When the setting of the remote control switch is changed, the control system energizes the pawl-actuating relay which lifts the

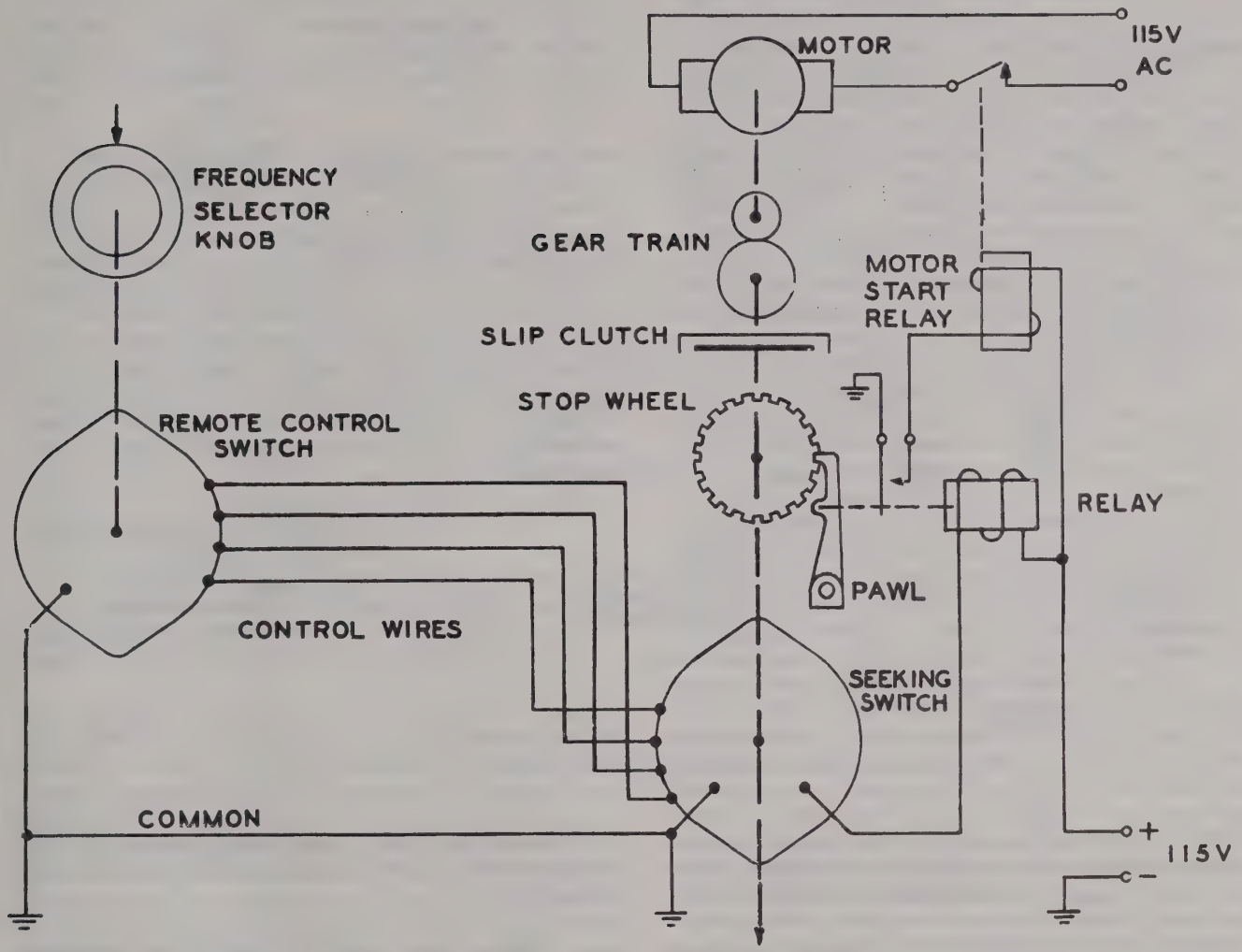


Figure 4-18. Autopositioner, Functional Schematic

pawl out of the stop-wheel notch and, at the same time, closes a set of contacts, causing the motor start relay to energize. The motor control contacts close, starting the motor which drives the autopositioner shaft and the rotor of the seeking switch. When the seeking switch reaches the point corresponding to the new position of the remote control switch, the circuit for the pawl-actuating relay opens, causing this relay to deenergize and permit the pawl to drop into a corresponding stop-wheel notch to stop the shaft rotation. At the same time, the contacts which complete the circuit for the motor start relay are opened, deenergizing the relay and opening the motor control contacts. The motor coasts to a stop, dissipating its kinetic energy in the slip clutch.

4-95. The seeking switch of the control circuit is adjusted to open the relay circuit shortly before the stop-wheel reaches the point where the pawl engages the proper notch. The relay contacts controlling the motor start relay are mechanically operated by the pawl arm so that they do not open until the pawl drops into the notch. The slip clutch between the motor and the autopositioner not only absorbs the energy of the motor as it coasts to a stop, but also permits the same motor to drive more than one autopositioner either simultaneously or independently. The motor control contacts of the autopositioner motor start relays are connected in parallel to keep the motor operating as long as any of the autopositioners energized.

4-96. FREQUENCY SELECTOR CONTROL CIRCUIT.

4-97. A control circuit which is external to the frequency selector unit but directly associated with it includes motor control relay K1202, channel autopositioner control relay K1201 and TRACKING CONTROL switch S1207. (See figure 4-19.) Motor control relay K1202 has two sets of contacts. When the relay is energized through the operation of any of the autopositioner relays, one set of contacts applies 115 volts ac to the autopositioner motor, B1101. The other set of contacts energizes the MUTING relay, K802 (figure 4-16).

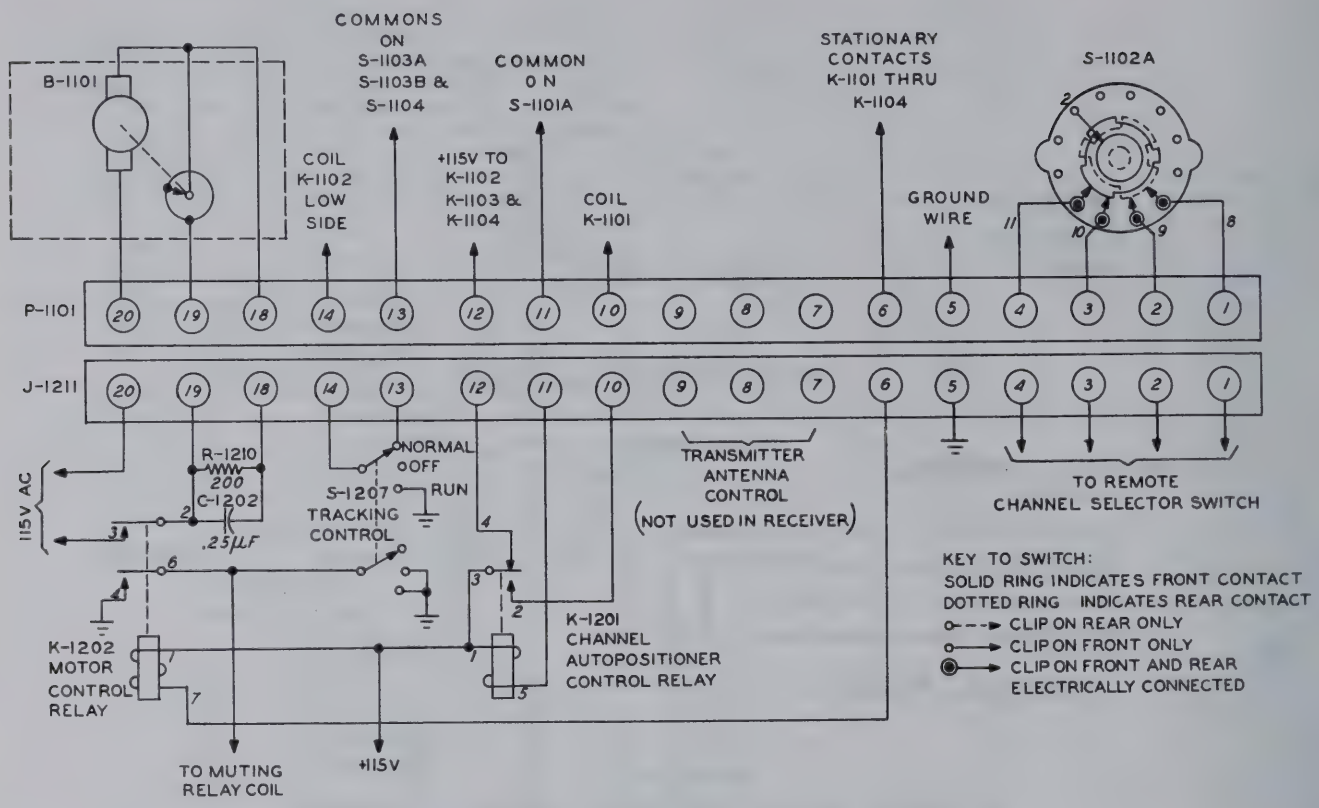


Figure 4-19. Frequency Selector Unit, External Connections

4-98. Channel autopositioner control relay K1201 requires a much lower value of current and will operate on a wider range of control voltages whan will the autopositioner relays. It is therefore useful in installations where the remote channel selector switch may be located as much as five miles from the receiver and the resistance of the control wires is appreciable. When the channel autopositioner relay is operated by the control circuit, it actuates channel autopositioner relay K1101 and removes power from the other autopositioner relays (K1102, K1103, and K1104), thereby preventing their operation until the channel autopositioner has completed its cycle.

4-99. TRACKING CONTROL switch S1207 is used as an aid in servicing and aligning the equipment. (See figure 4-19.) When this switch is in the NORMAL position, operation of the frequency selecting system is as previously explained. With the TRACKING CONTROL switch in the RUN position, 10-mc autopositioner relay K1102 is continuously energized. By placing this switch in the RUN position and then returning it to the OFF position at the correct instant, it is possible to stop the 10-mc autopositioner at any point for access to the adjustments.

4-100. SEQUENCE OF OPERATION, LOCAL CONTROL.

4-101. Operation of the frequency selecting system is as follows when local Channel selector switch S1101A is moved from channel 1 to the MANUAL position. (See figure 7-2.)

a. Channel seeking switch S1102B is no longer in a position corresponding to that of CHANNEL SELECTOR switch S1101A and channel autopositioner control relay K1201 is energized by way of the following path: +115-volt d-c supply, solenoid of channel autopositioner control relay K1201, pins 11 of J1211 and P1101, common contact of S1101A, terminal 1 of S1101A, terminal 1 of S1102B, common contact of S1102B, pins 5 of P1101 and J1211 to ground.

b. The contacts of the channel autopositioner control relay K1201 operate, switching the positive side of the relay supply from pin 12 to pin 10 of J1211. This prevents relays K1102, K1103, and K1104 from operating until after the channel autopositioner has completed operation.

c. Channel autopositioner relay K1101 is energized, lifting the pawl out of the channel autopositioner notched stop-wheel and also operating two sets of contacts. The normally-closed contacts open to place resistor R1101 in series with the coil of K1101 to limit the current through the coil to a low value sufficient to hold the relay energized. The normally-open contacts clost to energize motor control relay K1202 through pins 6 of P1101 and J1211.

d. One set of contacts on relay K1202 close and disable the receiver by energizing muting relay K802. Another set of contacts close and energize autopositioner motor B1101 by applying 115 volts ac to its windings.

e. Motor B1101 drives the clutch gears of the four autopositioners through a step down geared coupling. Only the channel autopositioner stop-wheel is free to turn, while the stop-wheels of the other three autopositioners are locked by their pawls, causing their respective clutches to slip.

f. The channel autopositioner shaft revolves until local (panel control) seeking switch S1102B finds its open circuit position; in this case the MANUAL position of CHANNEL SELECTOR switch S1101A. At the same time, the channel autopositioner shaft drives the three channel selector switches S1102C, S1102D, and S1102E, and the channel indicator dial to the position corresponding to the MANUAL position.

g. When local channel seeking switch S1102B finds its open position, relays K1201 and K1202 deenergize and transfer the positive voltage supply from pin 10 back to pin 12 of J1211.

h. Channel autopositioner relay K1101 becomes deenergized and, due to the change in positioning of the channel selector switches, relays K1102, K1103, and K1104 become energized. The coils of relays K1102, K1103, and K1104 are connected to ground through their associated seeking switches, the manual preset switches and the channel selector switches, the common contacts of which are connected to ground. In the case of the 10-mc autopositioner relay coil, the NORMAL position of TRACKING CONTROL switch S1207 is included in the grounding path.

i. The control circuit of motor B1101 is energized through the contacts of the autopositioner relays, thereby causing the motor to operate and drive the 10-mc, 1.0-mc, and 0.1-mc autopositioner seeking switches.

j. When the 10-mc, 1.0-mc, and 0.1-mc autopositioner seeking switches find their open-circuit position, their respective relays, K1102, K1103, and K1104, deenergize and drop their pawls into the correct notch of the stop-wheel. This prevents any further rotation of the 10-mc, 1.0-mc, and 0.1-mc autopositioner output shafts. The autopositioners are now correctly positioned at the selected frequency and are deenergized along with the autopositioner motor.

4-102. The operation of the 10-mc seeking switch is more involved than that of the 1.0-mc and 0.1-mc seeking switches and is discussed in greater detail in this paragraph. The 10-mc autopositioner system employs a mechanical and electrical combination of three rotary switches, each having a 12-point stator to give 36 electrical positions. (See figure 7-2.) Eighteen positions establish the 18 frequencies which are spaced at 10-mc intervals, while the remaining 18 positions are unused except to provide a return of the tuning mechanism to its starting position. Two 10-mc seeking switches, S1103A and S1103B, are a rotary-wafer type whose two sides are complementary to each other so that every switch position makes contact with either the front or the rear rotor. The third switch, S1104, is designated as the blanking switch and acts to distinguish between the first, second, and third revolutions of the two seeking switches. For the first 270-degree revolution of the seeking cycle, the blanking switch allows seeking switch S1103A to investigate its nine used positions for an open-circuited condition that will deenergize the control circuits. At the same time, it rejects all positions of seeking switch S1103B by shorting together the front and rear rotor blades. For the next 270-degree revolution of the seeking cycle, the blanking switch allows seeking switch S1103B to investigate its nine active positions while rejecting all positions of seeking switch S1103A by shorting together its front and rear rotor blades. During the last 540-degree revolution of the seeking switches, the blanking switch rejects all positions of both seeking switches by shorting together the front and rear rotor blades of both switches. This interval allows the tuning mechanism to travel to its original or starting location. The exact instant at which the two wipers on the blanking switch make or break contact with the blanking switch rotor is not critical, since there are three unused positions each on seeking switches S1103A and S1103B that are being investigated at the time the corresponding wiper is making or breaking contact with the rotor of the blanking switch. This allows a suitable tolerance in the alignment of the blanking switch.

4-103. REMOTE OPERATION.

4-104. The frequency selector unit may be operated by remote control from Control Indicator C-806/GR. To provide a positive control system for the autopositioners with a minimum number of control wires, a simplified system employing four control wires in various combinations is used when operating from a remote location.

4-105. A basic system of this type is composed of a number of single-pole, double-throw switches. (See figure 4-20.) When the switches are set symmetrically (S1 in the same position as S2, etc., as shown), there is no current path from the relay coil to ground. If any one of the control switches is set to a position opposite from that of the corresponding seeking switch, a current path to ground will be made causing the relay and the motor to energize. When the seeking switches are rotated to positions corresponding to the remote switches the relay circuit will again open.

4-106. The control system uses special rotary-type wafer switches, each switch consisting of two rotor blades mounted on opposite sides of the switch rotor and insulated from each other. These take the place

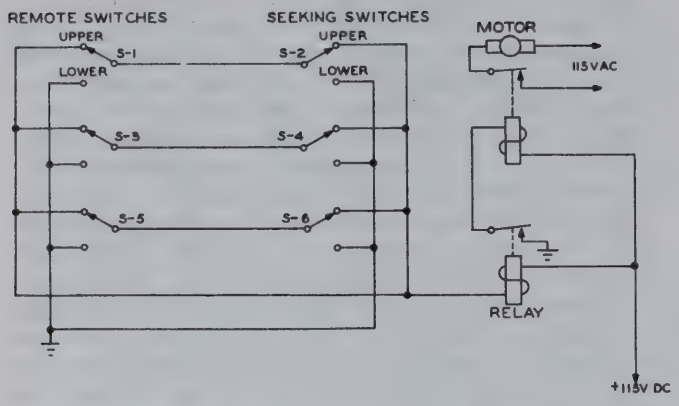


Figure 4-20. Basic Binary Control System, Simplified Schematic

of the upper and lower parallel-bus connections shown in figure 4-20.

4-107. SEQUENCE OF OPERATION, REMOTE CONTROL.

4-108. CHANNEL SELECTOR switch S1101 must be set to the REMOTE position to permit remote selection of channels. This transfers control of the channel autopositioner from the local CHANNEL SELECTOR switch to the remote channel selector switch. The system is at rest (relays and motor deenergized and pawl engaging the stop-wheel notches) when the remote channel selector switch and the remote seeking, S1102A, are in corresponding positions (open circuit). The following operation takes place when the remote operator changes the setting of the remote channel selector switch. (See figure 4-21.)

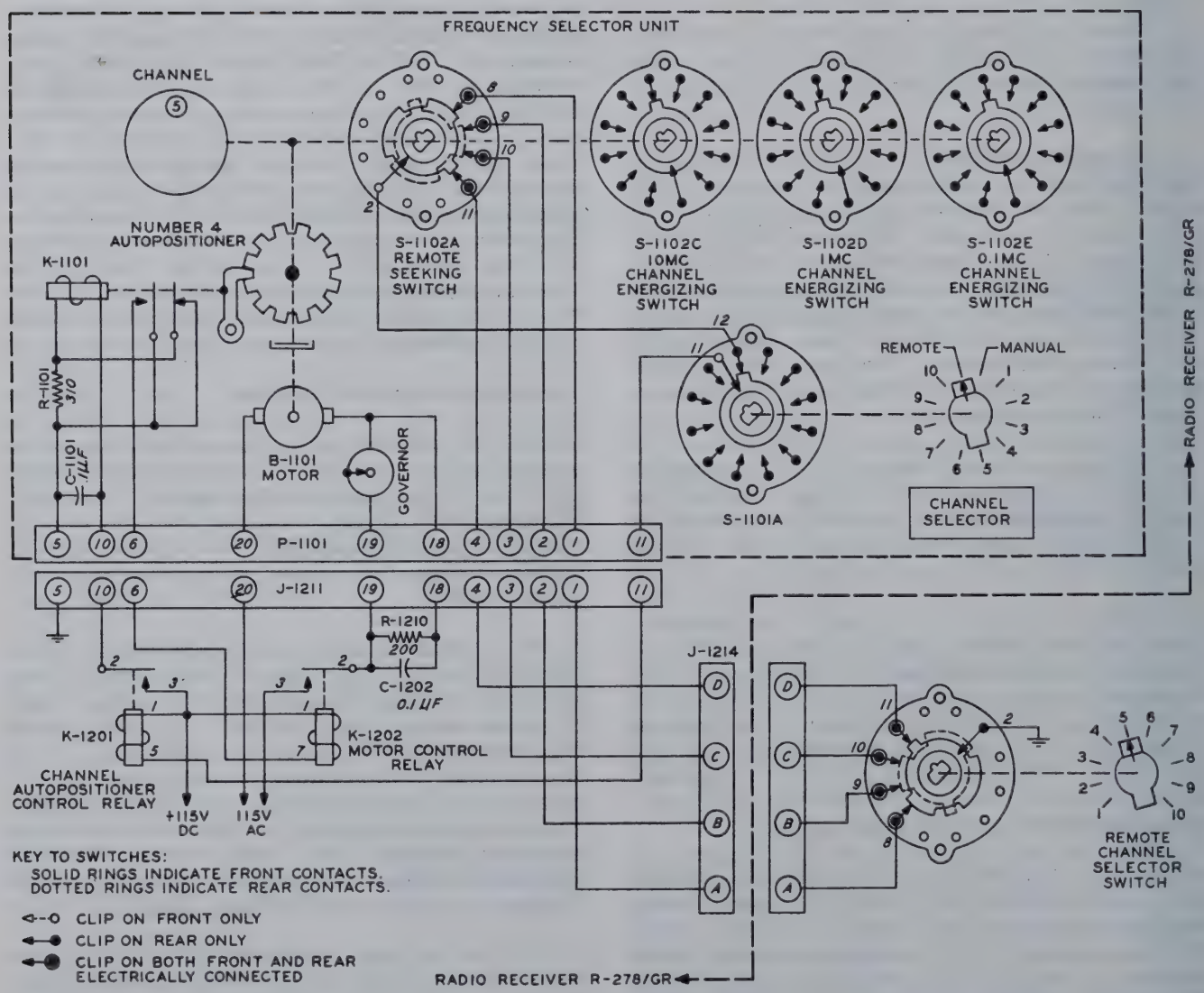


Figure 4-21. Remote Frequency Selecting System, Simplified Schematic

a. Channel autopositioner control relay K1201 is energized through pins 11 on J1211 and P1101, the rotor blade of S1101A, the rotor blade of remote seeking switch S1102A, and the control wires leading to the remote channel selector switch, one or more of which are connected to ground through the rotor blade.

b. The contacts of channel autopositioner control relay K1201 are closed, energizing channel autopositioner relay K1101.

c. Relay K1101 lifts its pawl out of the stop-wheel notch and also operates two sets of contacts. The normally-closed contacts open to place R1101 in series with the coil of K1101 to limit the current through the coil to a low value sufficient to hold the relay energized. The normally-open contacts close to energize motor control relay K1202 through pins 6 of P1101 and J1211.

d. The contacts of relay K1202 close and energize motor B1101 which drives the channel autopositioner shaft and the rotor of remote seeking switch S1102A.

e. When the remote seeking switch reaches the point corresponding to the new position of the remote channel switch, the ground connection is removed from channel autopositioner control relay K1201, causing it to deenergize.

f. The opening of the contacts of relay K1201 causes channel autopositioner relay K1101 to deenergize, thereby dropping its pawl into the stop-wheel notch to stop the shaft rotation.

The sequence of operation from this point is identical to that of the local operation as was discussed in paragraph 4-101.

4-109. MECHANICAL DRIVE.

4-110. The following is a typical operation fo the frequency selector mechanical drive system. (See figure 4-22.)

a. When the channel selector switch is repositioned, the channel autopositioner becomes energized so that its pawl releases its stop-wheel and a set of contacts actuates the motor.

b. The motor drives the clutch plates of the four autopositioners through a series of gears. Only the channel autopositioner shaft turns. All other clutches slip, since their pawls lock their associated stop-wheels.

c. The channel indicator and channel switches move to the selected position. This action energizes the remaining three autopositioners.

d. The channel autopositioner pawl engages the stop-wheel while the other three pawls release their stop-wheels.

e. The motor drives the three frequency-determining autopositioners through their clutches.

4-111. The 0.1-mc autopositioner uses a direct drive output and the indicator dial is geared 1:1 to the output shaft. The 1.0-mc autopositioner uses a gear ratio of 2:1 to drive both the 1.0-mc indicator dial and the 1.0-mc tuning shaft. Therefore, the 1.0-mc autopositioner makes two complete revolutions to complete a tuning cycle. The 10-mc autopositioner is geared to the tuning mechanism in such a way that six complete revolutions of the 10-mc autopositioner are required to complete one tuning cycle. Seeking switches S1103A and S1103B make three revolutions, blanking switch S1104 makes one revolution, and the 10-mc indicator dial makes two revolutions.

4-112. TUNING MECHANISM, FUNCTIONAL OPERATION.

4-113. The three shafts of the frequency selector unit, either singly or in combination, correctly position the tuned elements and selector switches to provide completely automatic tuning of the receiver. The subassemblies listed below are supplied with inputs from the corresponding tuning shafts. (See figure 4-23.)

R-f amplifier	10-mc and 1.0-mc shafts
Main oscillator	10-mc shaft
Frequency multiplier-amplifier	10-mc shaft
First i-f amplifier	1.0-mc and 0.1-mc shafts
Second i-f amplifier	0.1-mc shaft

4-114. The second i-f amplifier has one mechanical input, that from the 0.1-mc autopositioner shaft. The gearing ratio is 1:1, so that one revolution of the 0.1-mc autopositioner shaft effects a complete tuning cycle of the second i-f amplifier. Two cams mounted on the tuning shaft of the second i-f amplifier turn 270 degrees to raise the tuning-core table from its lowest position to its highest position to permeability-tune the primaries and secondaries of transformers T501 and T502. The remaining 90 degrees of cam travel allows the tuning rack to drop to its lowest position, which represents the highest tuning frequency. A rotary crystal selector switch having 10 active positions in 270 degrees is mounted on the end of the tuning shaft to select the proper third oscillator crystal unit for the receiver frequency selected.

4-115. The first i-f amplifier unit receives two mechanical inputs on two parallel tuning shafts. The input from the 0.1-mc autopositioner is geared 1:1 through an idler gear and the input from 1.0-mc autopositioner is geared 2:1 since the 1.0-mc autopositioner makes two revolutions for one tuning cycle.

4-116. The amplifier section i-f transformers, T401 and T402 are permeability-tuned by a differential tuning core table which combines the inputs from the 1.0-mc and 0.1-mc autopositioners to provide 100 tuning steps. The cams mounted on the floating 1.0-mc tuning shaft position the tuning core table in 10 steps similar to the tuning of the second i-f amplifier. The cams mounted on the 0.1-mc tuning shaft displace this 1.0-mc tuning shaft in 10 steps to provide a vernier adjustment of the tuning core table position. The Oldham-type sliding coupler permits the floating 1.0-mc tuning shaft to be thus displaced.

4-117. The tuned circuits associated with the second oscillator are permeability-tuned in 10 steps by a tuning core table positioned by means of two cams mounted on the fixed-bearing 1.0-mc tuning shaft. The crystal selector switch of the second oscillator is operated from the fixed-bearing 1.0-mc tuning shaft through an idler gear.

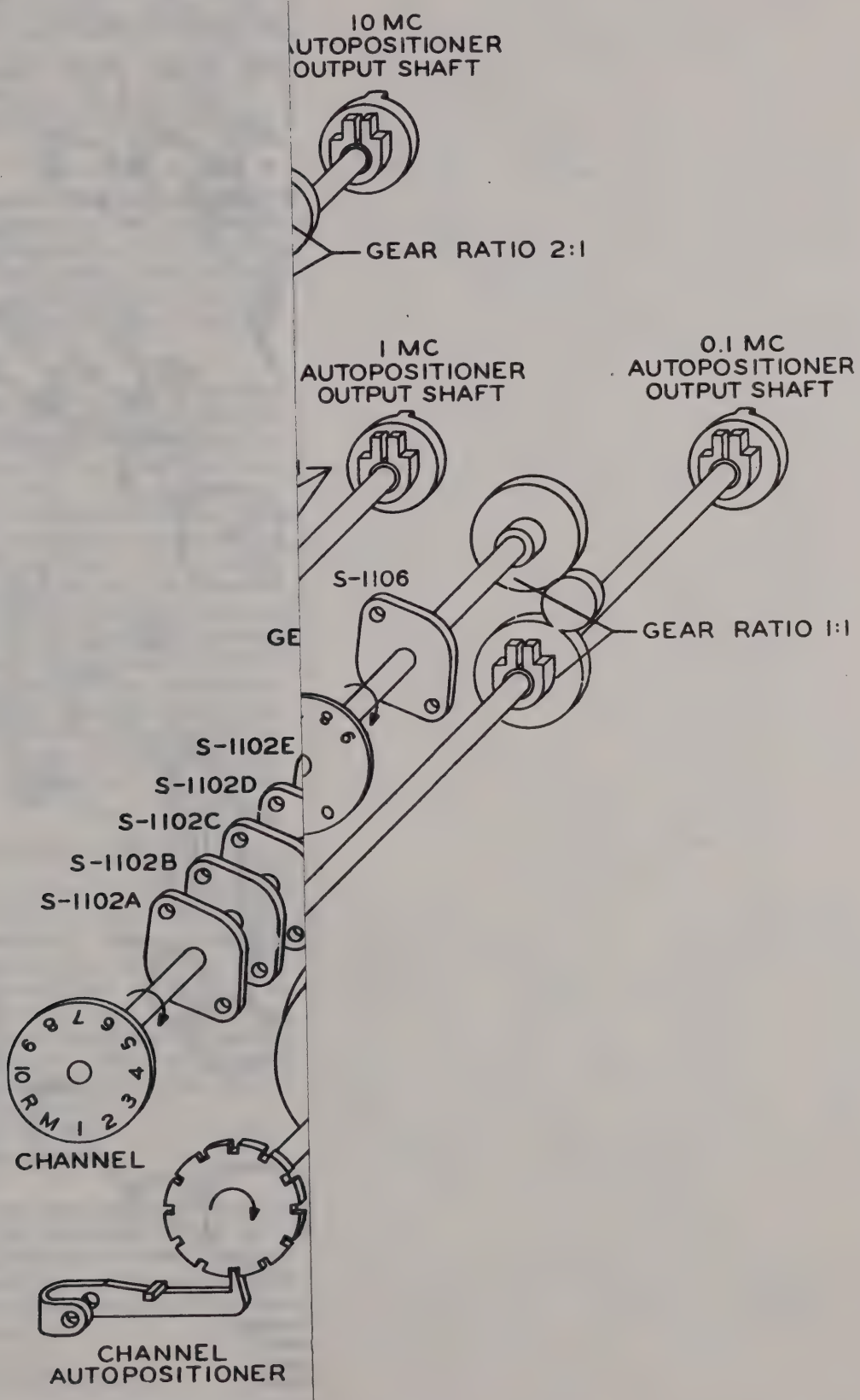
4-118. The main oscillator unit crystal selector switch and coil selector switch are driven from the 10-mc autopositioner shaft through a 3:1 gear reduction. Since the 10-mc autopositioner shaft makes six revolutions per tuning cycle, these selector switches make two complete revolutions per cycle. The first revolution provides 18 rotor positions for the selection of the proper crystal and coil for the selected receiver frequency. The second revolution occurs at the time the frequency multiplier-amplifier tuners and r-f amplifier of the frequency multiplier-amplifier are in the unused 180 degrees of their tuning cycle.

4-119. The tuning shaft of the frequency multiplier-amplifier is driven by the 10-mc autopositioner shaft through two stages of gear reduction which provide a speed reduction f 6:1. Thus the tuners make one revolution per tuning cycle. The first 180 degrees of rotation provide the 18 operating positions of the tuners. The second 180 degrees of rotation return the tuners to the starting point of their cycles. The gears employed in the reduction drive are of the split, spring-loaded type to reduce possible inaccuracies due to backlash.

4-120. The tuners of the frequency multiplier-amplifier are driven by the tuning shaft through a system of spur gears which, with the exception of the gears driving the toroidal step tuner, are also of the split spring-loaded type.

4-121. The r-f amplifier tuning shaft is driven from the 10-mc autopositioner shaft through a gearing system which includes a planetary-type differential in which the tuning information provided by the 10-mc autopositioner shaft is combined with tuning information provided by the 1.0-mc autopositioner shaft to provide 180 operating positions of the r-f amplifier tuners. The 1.0-mc input is accomplished by a rocker arm driving a pinion of the planetary gear system. This rocker arm is actuated by a cam driven from the 1.0-mc autopositioner shaft. This cam has its periphery radius-stepped, so that the rocker arm always rides on circle segments with increasing radii as the frequency increases from the zero position through the nine position.

4-122. The driving gears provide a 3:1 speed reduction from the 10-mc autopositioner shaft and an additional 2:1 reduction is obtained in the differentail mechanism. Thus, the tuning shaft makes one revolution per tuning cycle to provide 18 primary tuning positions, each of which is divided into 10 steps as determined by the setting of the 1.0-mc autopositioner shaft operating through the differential mechanism. Thus, 180 positions covering 180 degrees of rotation are provided. The tuning shaft is coupled back to the 10-mc autopositioner shaft through a system of loading gears and a helical spring to provide spring-loading of the entire gear train. The r-f amplifier tuners are driven by the tuning shaft through a system of spur-gears employing split spring-loaded gears.



or Unit, Pictorial Diagram

4-116. The amplifier section i-f transformers, T401 and T402 are permeability-tuned by a differential tuning core table which combines the inputs from the 1.0-mc and 0.1-mc autopositioners to provide 100 tuning steps. The cams mounted on the floating 1.0-mc tuning shaft position the tuning core table in 10 steps similar to the tuning of the second i-f amplifier. The cams mounted on the 0.1-mc tuning shaft displace this 1.0-mc tuning shaft in 10 steps to provide a vernier adjustment of the tuning core table position. The Oldham-type sliding coupler permits the floating 1.0-mc tuning shaft to be thus displaced.

4-117. The tuned circuits associated with the second oscillator are permeability-tuned in 10 steps by a tuning core table positioned by means of two cams mounted on the fixed-bearing 1.0-mc tuning shaft. The crystal selector switch of the second oscillator is operated from the fixed-bearing 1.0-mc tuning shaft through an idler gear.

4-118. The main oscillator unit crystal selector switch and coil selector switch are driven from the 10-mc autopositioner shaft through a 3:1 gear reduction. Since the 10-mc autopositioner shaft makes six revolutions per tuning cycle, these selector switches make two complete revolutions per cycle. The first revolution provides 18 rotor positions for the selection of the proper crystal and coil for the selected receiver frequency. The second revolution occurs at the time the frequency multiplier-amplifier tuners and r-f amplifier of the frequency multiplier-amplifier are in the unused 180 degrees of their tuning cycle.

4-119. The tuning shaft of the frequency multiplier-amplifier is driven by the 10-mc autopositioner shaft through two stages of gear reduction which provide a speed reduction f 6:1. Thus the tuners make one revolution per tuning cycle. The first 180 degrees of rotation provide the 18 operating positions of the tuners. The second 180 degrees of rotation return the tuners to the starting point of their cycles. The gears employed in the reduction drive are of the split, spring-loaded type to reduce possible inaccuracies due to backlash.

4-120. The tuners of the frequency multiplier-amplifier are driven by the tuning shaft through a system of spur gears which, with the exception of the gears driving the toroidal step tuner, are also of the split spring-loaded type.

4-121. The r-f amplifier tuning shaft is driven from the 10-mc autopositioner shaft through a gearing system which includes a planetary-type differential in which the tuning information provided by the 10-mc autopositioner shaft is combined with tuning information provided by the 1.0-mc autopositioner shaft to provide 180 operating positions of the r-f amplifier tuners. The 1.0-mc input is accomplished by a rocker arm driving a pinion of the planetary gear system. This rocker arm is actuated by a cam driven from the 1.0-mc autopositioner shaft. This cam has its periphery radius-stepped, so that the rocker arm always rides on circle segments with increasing radii as the frequency increases from the zero position through the nine position.

4-122. The driving gears provide a 3:1 speed reduction from the 10-mc autopositioner shaft and an additional 2:1 reduction is obtained in the differentail mechanism. Thus, the tuning shaft makes one revolution per tuning cycle to provide 18 primary tuning positions, each of which is divided into 10 steps as determined by the setting of the 1.0-mc autopositioner shaft operating through the differential mechanism. Thus, 180 positions covering 180 degrees of rotation are provided. The tuning shaft is coupled back to the 10-mc autopositioner shaft through a system of loading gears and a helical spring to provide spring-loading of the entire gear train. The r-f amplifier tuners are driven by the tuning shaft through a system of spur-gears employing split spring-loaded gears.

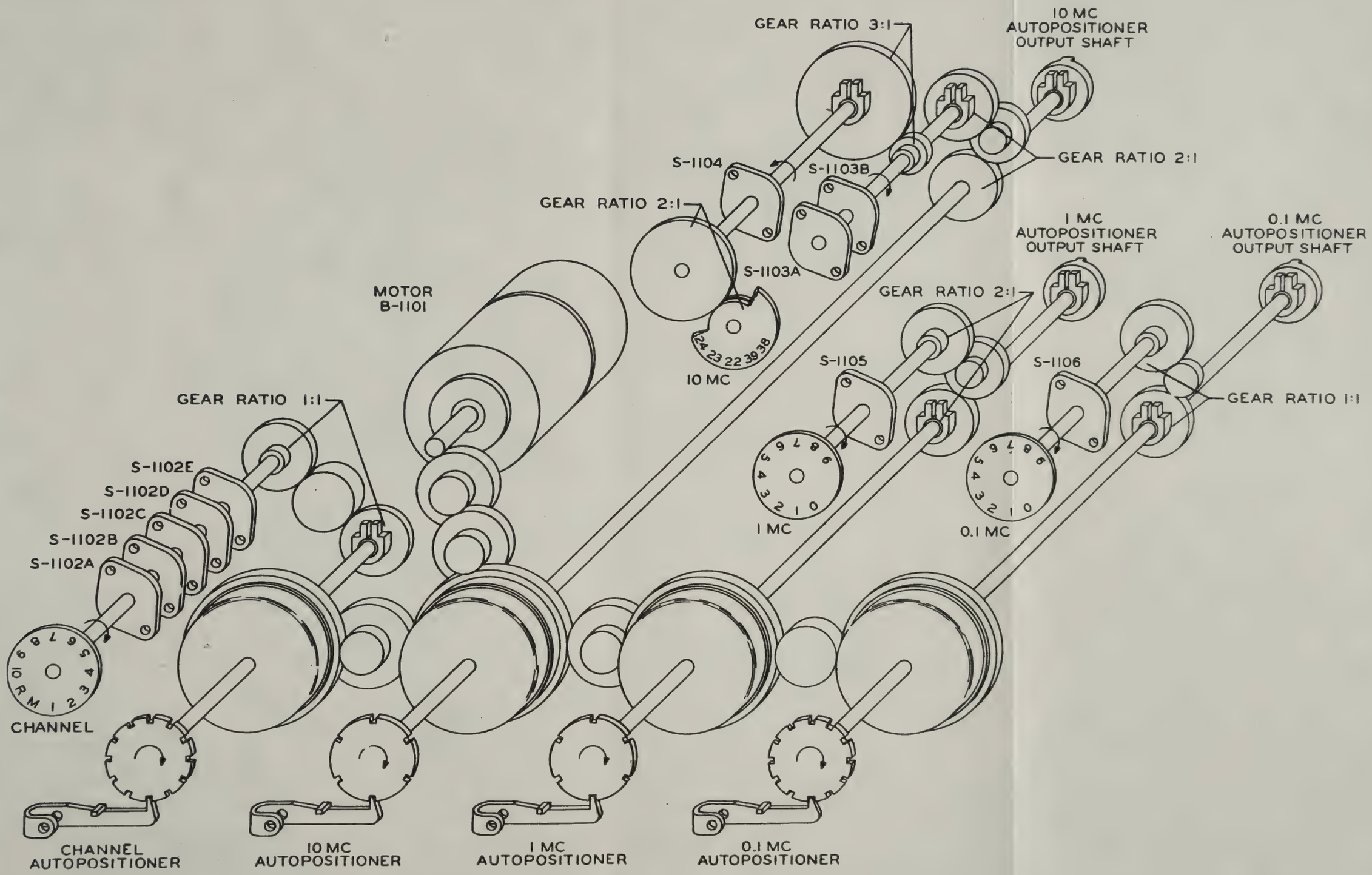


Figure 4-22. Frequency Selector Unit, Pictorial Diagram

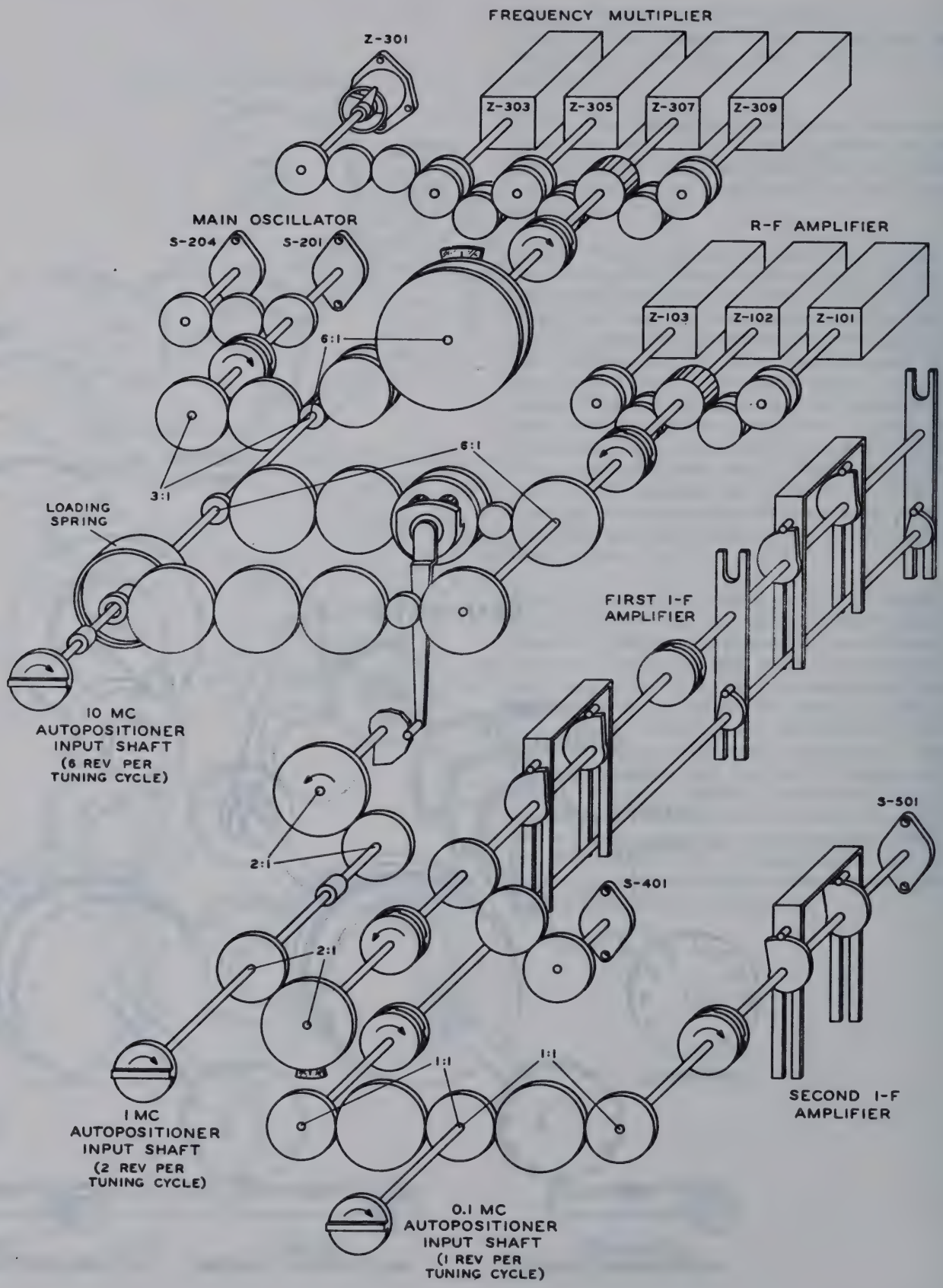


Figure 4-23. Tuning System, Pictorial Diagram

SECTION V
ORGANIZATIONAL MAINTENANCE

5-1. GENERAL.

5-2. This section contains system maintenance procedures for Radio Receivers R-278/GR, R-278A/GR, and R-278B/GR. These procedures are to be used by personnel with a previous knowledge of the equipment's physical makeup and operating characteristics; and with a good understanding of the circuit theory of operation.

5-3. The instructions, procedures, and other information contained in this section enable personnel to determine the operational status of the equipment, to predict future malfunctions, and to isolate troubles to a specific area of the receiver. The minimum performance standards table includes procedures which enable personnel to check significant points in the equipment as to correct function. The inspection schedules and lubrication procedures are to be used by personnel as preventive maintenance procedures for minimizing future failures. The tabulated troubleshooting information permits the isolation of a trouble to a specific subassembly, and also incorporates corrective measures, including alignment procedures. The detailed troubleshooting tables in Section VI will pick up from this point so that a breakdown can be localized to a specific part such as a tube, relay, or transformer.

5-4. MINIMUM PERFORMANCE STANDARDS.

5-5. The information in Table VIII is to be used by maintenance personnel to determine the general operational status of the equipment. These procedures should be followed to prepare the equipment for tactical operation and to ascertain that all functions for which the equipment is intended may be performed when necessary. If the standard indications as listed in Table VIII are not obtainable, refer to the indicated step(s) of the system troubleshooting table for the proper corrective measures.

5-6. PRELIMINARY INSPECTION.

5-7. A preliminary visual inspection of the equipment should be performed by the maintenance personnel to ascertain that the equipment has not been damaged during shipment and installation. Personnel should check the items listed in Table IX and report damaged items to the proper authorities.

5-8. SYSTEM TROUBLE ANALYSIS.

5-9. The information contained in the system trouble analysis table is intended to aid maintenance personnel in identifying, partially localizing, and correcting troubles within Radio Receivers R-278/GR, R-278A/GR, and R-278B/GR. This information should not be regarded as a substitute for common sense nor as the sole method for correcting malfunctioning equipment. It is assumed that maintenance personnel are thoroughly familiar with the operating procedures and general equipment characteristics, and also have a good understanding of circuit operation. Abnormal indications are more readily apparent when maintenance personnel know what to expect under conditions of normal operation.

5-10. Most of the troubleshooting involves these processes: determining the defective subassembly, removing the defective subassembly from the receiver, and troubleshooting and repairing the defective subassembly. Table X is to be used as an aid in determining a defective subassembly, while the procedures for further troubleshooting of that subassembly are listed in the detailed trouble analysis table of Section VI. The information contained in Table X is based upon the supposition that primary power to the equipment is being supplied in a normal manner. If the procedures in this table do not provide the necessary corrective action, the lack of proper power input to the equipment should be considered as a possible source of trouble, and the proper steps taken.

5-11. REMOVAL AND REPLACEMENT.

5-12. The subassemblies of the receiver are fastened to the main chassis (receiver housing) by means of captive screws whose heads are painted red to aid in identification. Electrical connection between the subassemblies is accomplished by the use of cables terminated in plugs and, in some instances, by short wire runs terminated in soldered connections. Mechanical linkage between subassemblies is obtained by the use of Oldham couplers with gear trains employed to rotate the various shaft at the desired rate. All electrical connections to a subassembly should be disconnected before loosening the captive screws to remove the subassembly.

WARNING

Turn off the equipment before removing any subassemblies from the receiver.

5-13. Before removing or replacing a subassembly which is mechanically connected to the frequency

TABLE VIII. SYSTEM MINIMUM PERFORMANCE STANDARDS

STEP	CHECK	PROCEDURE	STANDARD INDICATION	IF ABNORMAL REFER TO
1.	Receiver sensitivity	Set the front panel controls to the following positions: MAIN R-F GAIN R1207 full CW, AVC TIME CONSTANT S1204 at COMM, AVC S1202 at ON (on receivers R-278A/GR and R-278B/GR this position is LOCAL), FREQ RESPONSE S1203 at BROAD, SQUELCH S1205 at ON, QUIETING R1204 at full CCW. Connect a signal generator to ANTENNA jack J1212 and adjust for 6- microvolt output, modulated 30% with a 1000-cps tone at the receiver operating frequency. Connect an output meter to PHONES jack J1213 and a vtvm to AVC jack J606. Adjust AF GAIN control R1205 for a reading of 30 db on the output meter; then remove the modulation from the signal generator.	The signal-to-noise ratio should be 10 db or more for all receiver operating frequencies.	Table X, steps 1 and 2.
2.	Receiver selectivity	The selectivity of the receiver is determined by the selectivity of the third i-f amplifier. The procedure for this measurement is given in step 5 of Table XV (Detailed Minimum Performance Standards).	The bandwidth should be less than 225 kc for receiver R-278/GR. For receivers R-278A/GR and R-278B/GR, the bandwidth should be less than 185 kc.	Table X, step 3.
3.	Receiver output	Set the front panel controls as listed in step 1 through 9, and position the AF GAIN R-1205 at full CW. Set the receiver frequencytto 303.3 mc. Connect a signal generator turned to the receiver frequency to ANTENNA jack J1212 and adjust for 100-microvolt output, modulated 30% with a 1000-cps tone. Connect an output meter to PHONES jack J1213.	The reading on the output meter should be at least 35 dbm.	Table X, steps 1 and 2.
4.	Carrier-operated relay sensitivity	a. Set the front panel controls as listed in step 1 with the exception of FREQ RESPONSE switch S1203 which should be set to NARROW. Set the receiver frequency to 303.3 mc. Connect a signal generator tuned to the receiver frequency to ANTENNA jack J1212, and a vtvm to AVC jack J606. Increase the output of the signal generator from zero until the carrier-operated relay energizes (CARRIER indicator lights).	a. The signal level is necessary should be less than 3 microvolts. (The receiver noise may even operate the relay with no signal input.)	Table X, step 4.

TABLE VIII. SYSTEM MINIMUM PERFORMANCE STANDARDS (cont)

STEP	CHECK	PROCEDURE	STANDARD INDICATION	IF ABNORMAL REFER TO
		b. With conditions as above, place MAIN RF GAIN control (RF GAIN on R-278B/GR) R1207 in its full CCW position. Again, slowly increase the output of the signal generator until the carrier-operated relay energizes.	b. The signal level necessary should be greater than 50 microvolts.	Table X, step 4.
5.	Reset ability	Set the front panel controls as listed in step 1. Set the receiver frequency to 303.3 mc. Connect a signal generator tuned to the receiver frequency to ANTENNA jack J1212 and adjust for a 6-microvolt output. Adjust MAIN RF GAIN control R1207 until the carrier-operated relay just energizes (CARRIER indicator lights). Change the receiver frequency and return the signal generator output to zero. Then, reset the receiver to the original frequency (303.3 mc). Slowly increase the output of the signal generator until the carrier-operated relay again energizes.	The signal level necessary should not be more than 7.5 microvolts. (This represents a change of 2 db in signal voltage input.)	Table X, step 5.
6.	Frequency selection	Rotate CHANNEL SELECTOR switch S1101 to each channel position, successively.	Operating frequency of receiver at each position of CHANNEL SELECTOR switch S1101 corresponds to frequencies set up on receiver preset panel.	Table X, step 6.

TABLE IX. PRELIMINARY INSPECTION

ITEM	WHAT TO LOOK FOR
Dust cover	Dust cover fits securely over and attaches to the receiver housing.
Subassemblies	Subassemblies are properly secured in place.
Tubes and fuses	All tubes and fuses are in place, not broken, and properly seated.
Cable connectors	All cable connectors are properly secured in place.
Switches and controls	All switches and controls operate properly (mechanically).
Indicators	Meter and visual indicator glass is in unbroken state.

selector unit, the equipment should be set to the reference frequency of that subassembly as listed below.

First i-f amplifier	399.9 mc
Second i-f amplifier	399.9 mc
Frequency selector unit	390.0 mc
R-f amplifier	360.5 mc
Main oscillator	220.0 mc
Frequency multiplier-amplifier	220.0 mc

After the equipment is set to the reference frequency, reference marks should be placed on adjacent gears of the unit to be removed so that they may be returned to their original position when replacing the subassembly. If the frequency selector unit is inoperative for any reason, the frequency to which it is set should be noted prior to its removal, and it should be returned to this frequency before replacement.

5-14. LUBRICATION.

5-15. Components requiring lubrication should be inspected at 1000-hour intervals. If the parts appear to be clean, sufficiently lubricated and free running, lubrication may be omitted until the following inspection period. If lubrication is required, clean the parts if necessary, and apply a minimum amount of the specified lubricant. Gear teeth should be given a thin coating of lubricant MIL-G-3278. This lubricant should be applied by means of a small brush. Bearings require a small amount of lubricant MIL-L-7870A. Only a small amount of this lubricant should be applied at one time with the aid of a suitable applicator.

5-16. INSPECTION SCHEDULE.

5-17. A schedule for checking those areas of the equipment shich are subjected to the greatest amount of wear is presented in Table XI.

5-18. DETAILED SYSTEM ALIGNMENT.

5-19. Detailed alignment procedures are necessary upon initial installation, where a large number of subassemblies have been replaced or when the equipment has been idle for a lengthy period. The following paragraphs contain tuning and adjustment procedures necessary to maintain the performance standards expected of this equipment. All tests, alignments, and adjustments should be recorded for future reference. Dial settings and voltage and current readings are important aids to preventive maintenance. Prior to adjustments or alignments, an appraisal of the equipment should be made to determine to what extent alignment is required. In general, servicing will involve the realignment of one or more subassemblies. In most cases, this will involve only slight readjustments so that many of the detailed procedures given may be omitted.

WARNING

Contact with some of the voltages present in this equipment may be fatal. When operating the equipment outside of the dust cover, use extreme care to avoid contact with these high-voltage circuits.

5-20. MECHANICAL ALIGNMENT CHECK.

5-21. With the dust cover removed, check the receiver for mechanical alignment and synchronization by following the steps listed in Table XII. If the indications in Table XII are not obtained, return the receiver to depot for a complete mechanical alignment and synchronization.

NOTE

The letter "x" indicates that the indication is applicable regardless of this dial setting.

5-22. ELECTRICAL ALIGNMENT.

NOTE

To short out interlock switch S1206, pull out plunger until it locks.

5-23. GENERAL.

5-24. The following procedures apply to the alignment of a complete unit. Check for mechanical synchronization using Table XII before proceeding with the electrical alignment.

NOTE 1

The r-f signal generator is not sufficiently accurate for the alignment of the various subassemblies of Radio Receiver R-278/GR without first checking the frequency of this signal generator against a frequency standard such as the frequency meter. It is recommended that the frequency of this signal generator be checked against the frequency meter prior to each alignment operation.

NOTE 2

TRACKING CONTROL switch S1207 is provided in the receiver as an aid in servicing and aligning the equipment. It is located in the extreme rear, upper right hand corner of the receiver. With this switch in the RUN position, 10-mc autopositioner relay K1102 is continuously

TABLE X. SYSTEM TROUBLE ANALYSIS

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Receiver inoperative on all frequencies; POWER indicator I1202 lit and fan motor running.	No d-c supply voltages.	Check power supply rectifier and filter. (See Table XVI.)
2. No output or insufficient output on all frequencies; normal frequency selection.	a. Defective r-f amplifier.	a. Check r-f amplifier. (See Table XVI.)
	b. Defective first injection system.	b. Check main oscillator and frequency multiplier-amplifier. (See Table XVI.)
	c. Defective first, second or third i-f amplifier.	c. Check first, second and third i-f amplifier. (See Table XVI.)
	d. Defective audio amplifier.	d. Check audio amplifier. (See Table XVI.)
3. Poor receiver selectivity (as determined by the check outlined in Table XV, step 5).	Third i-f amplifier not aligned properly.	Check the alignment of the third i-f amplifier as described in the detailed system alignment procedures (paragraphs 5-25-5-27).
4. Incorrect indication for carrier-operated relay sensitivity check with procedure as set up in Table VIII, step 4; receiver sensitivity and output normal.	Defective avc or squelch circuit.	Check the avc and squelch circuits in the third i-f amplifier. (See Table XVI.)
5. Incorrect indication for reset ability check with procedure as set up in Table VIII, step 5; receiver sensitivity and output normal.	Defective frequency selecting system.	Check frequency selector unit and mechanical linkage to all tuned elements. (See Table XVI.) NOTE For a complete alignment of the receiver, the unit should be returned to depot.
6. Receiver operative but will not change channels.	Defective frequency selecting system.	Check frequency selector unit. (See Table XVI.)

TABLE XI. INSPECTION SCHEDULE

ITEM	INSPECTION PERIOD	CHECK FOR
Mechanical system	Monthly	Excessive wear or binding.
Wiring	Monthly	Bared insulation or corrosion.

TABLE XI. INSPECTION SCHEDULE (cont)

ITEM	INSPECTION PERIOD	CHECK FOR
Plugs and receptacles	Monthly	Dirty contacts and poor mechanical connections.
Tubes	Monthly	Poor contact between prongs of tubes and their sockets.
Controls	Monthly	Looseness and erratic operation.
Motors	Monthly	Wearing and pitting of brushes.
Switches	Monthly	Wearing of contacts.
Indicators	Daily	Burnout of indicator lamps.

TABLE XII. RECEIVER MECHANICAL ALIGNMENT CHECKS

POSITION	INDICATION	FRONT PANEL DIAL FREQ.
1. Couplers behind front panel as observed from bottom of unit.	Scribe lines on couplers aligned with scribe lines on blocks.	390.0 mc
2. Calibrated dial ahead of first i-f amplifier.	"0"	xx0.x mc
3. Coupler ahead of second i-f amplifier.	Red dot up.	xxx.9 mc
4. Iron cores in i-f transformers in second i-f amplifier.	Position for smallest amount of core in coil (slightly out of valley in cam).	xxx.9 mc
5. Two couplers ahead of first i-f amplifier.	Both red dots in up position.	xx9.9 mc
6. Iron cores in i-f transformers in first i-f amplifier.	Position for smallest amount of core in coil (slightly out of valley in cam).	xx9.9 mc
7. Crystal switch in first i-f amplifier.	Switch on position "1" (40 mc crystal position).	xx9.x mc
8. Step cam in rear gear train.	Follower on highest point on cam.	xx0.x mc
9. Calibrated dial ahead of frequency multiplier-amplifier.	"39"	39x.x mc
10. Shaft driving frequency multiplier-amplifier.	Gear train is spring-loaded, removing backlash.	Any freq.
11. Shaft driving r-f amplifier.	Gear train is spring-loaded, removing backlash.	Any freq.
12. Coupler ahead of frequency multiplier-amplifier.	Red dot up.	22x.x mc

TABLE XII. RECEIVER MECHANICAL ALIGNMENT CHECKS (cont)

POSITION	INDICATION	FRONT PANEL DIAL FREQ.
13. Rotor bar in all four frequency multiplier-amplifiers.	Opposite eyelet at bottom of tuner (bar directly beneath driven shaft as viewed from top of tuner).	22x.x mc
14. Coupler ahead of r-f amplifier.	Red dot up.	360.x mc
15. Rotor bar in all three r-f amplifier tuners.	Vertical position directly above driven shaft.	390.x mc
16. Toroidal (step) tuner (Z301).	Clip on smallest turn of coil (should have tension holding clip against turn).	39x.x mc
17. Shaft driving toroidal (step) tuner (Z301).	No spring loading. Should be as small backlash movement as possible.	Any freq.
18. Shaft driving main oscillator.	No spring loading. Should be as small backlash movement as possible.	Any freq.
19. Coupler on shaft driving main oscillator.	Red dot towards bottom of receiver.	22x.x mc
20. Rotary switch selecting oscillator coils as observed through small hole between coils 22 and 39.	Contact should be on clip No. 22. Contact should be on clip No. 39.	22x.x mc 39x.x mc
21. Rotary switch selecting crystal from crystal board in oven of main oscillator.	Position No. 1 (38.8888-mc crystal position).	39x.x mc

energized. By placing the TRACKING CONTROL switch in the RUN position and then returning it to the OFF position at the correct instant, it is possible to stop the 10-mc autopositioner at any point for access to the adjustments.

5-25. ALIGNMENT AND ADJUSTMENT OF RADIO RECEIVER R-278()/GR THIRD IF AMPLIFIER.

5-26. GENERAL INFORMATION

a. The purpose of this routine is to align the Third IF Amplifier Unit.

b. The approximate time required to complete this procedure is one hour.

c. Allow the receiver to warm up for ten minutes before performing the following alignment.

WARNING

When Radio Receiver R-278()/GR is turned "ON", high voltage will be present on the exposed contacts.. The receiver can be placed in standby condition with only filament voltage applied by turning the TRACKING CONTROL Switch OFF. This switch located at the rear of the receiver chassis, should be positioned to OFF before the equipment is handled.

5-26A. TEST EQUIPMENT REQUIRED

a. Signal Generator AN/URM-25()
b. Electronic Multimeter 410B

5-26B. MATERIAL REQUIRED

a. Phillips screwdriver
b. 2200 ohm resistor

5-27. ALIGNMENT PROCEDURE

a. MAIN RF CONTROL R-1207 at 10.
b. AVC TIME CONSTANT Switch S-1204 in COMM Position.
c. AVC Switch S-1202 in ON position.
d. SQUELCH Switch S-1205 in OFF position.
e. Remove third i-f amplifier from receiver frame.
f. Remove bottom cover plate.
g. Replace electrical connections to receiver.
h. Remove tube V501 from second i-f amplifier.
i. Connect vtvm to avc jack J606. (AVC VOLTS jack J1218 located on front panel of R-278B/GR only, provides identical indication.)
j. Accurately adjust the signal generator to 2.05 mc using the frequency meter and connect the output to jack J503.

WARNING

Voltages dangerous to life are present in the exposed circuits when the receiver is energized in this position. Observe all high voltage safety precautions.

k. Adjust the output level of the signal generator to obtain not more than 3.0 volts on the vtvm during alignment.
l. Shunt the primary (terminals 1 and 2) of transformer T604 with a 2200-ohm damping resistor and tune the secondary (bottom) coil for maximum avc voltage.
m. Shunt the secondary (terminals 3 and 4) of transformer T604 with 2200-ohm resistor and tune the primary (top) coil for maximum avc voltage.

NOTE

Before attaching the damping resistor, turn off plate voltage by operating the TRACKING CONTROL switch to OFF.

n. Tune transformers T603, T602, and T601 using the same procedure as steps h and i.
o. If the transformers do not appear to tune, set the AVC switch to OFF position.
p. Connect the vtvm to jack J604 and tune for maximum indication of the diode load voltage until near resonance. Complete tuning using avc voltage as described above.

5-28. ALIGNMENTS AND ADJUSTMENTS OF RADIO RECEIVER R-278( )/GR SECOND I-F AMPLIFIER ALIGNMENT.

5-29. GENERAL INFORMATION.

a. The purpose of this routine is to align the Second I-F Amplifier Unit of Radio Receiver R-278( )/GR.
b. The approximate time required to complete this procedure is one hour.
c. Allow the receiver to warm up for ten minutes before performing the following alignment.

WARNING

When Radio Receiver R-278( )/GR is turned "ON', high voltage will be present on the exposed contacts. The receiver can be place in standby condition with only filament voltage applied by turning the TRACKING CONTROL switch to OFF. This switch, located at the rear of the receiver chassis, should be positioned to OFF before the equipment is handled.

5-30. TEST EQUIPMENT REQUIRED.

a. Signal Generator AN/URM-25( ).
b. Electronic Multimeter 410B.

5-31. MATERIALS REQUIRED.

a. Phillips Screwdriver. (No. 1 furnished with receiver.)
b. Slot Screwdriver.
c. Headset, CW-49507.
d. Hook-up wire, No. 22 AWG, length as required.
e. Resistor, 50-ohm, one-half watt, carbon type.
f. CX-1174/U, Power Cable, or equivalent.
g. Screwdriver, nonmetallic.

5-32. PROCEDURE.

a. Set the POWER ON-OFF switch on the front of Radio Receiver R-278( )/GR to the OFF position.

b. Disconnect all cables from the front of the receiver.

c. Remove the receiver from the rack, place the unit on a test bench, and remove the dust cover.

d. Pull the interlock plunger at the rear of the unit to its full outward position and set the TRACKING CONTROL to NORMAL. The TRACKING CONTROL is located at the rear of the receiver chassis.

e. Connect an a-c power cable from an a-c source to the 50-60 POWER connector on the front panel of the receiver.

f. Plug the headset into the PHONES receptacle on the front of the receiver.

g. Remove the Third I-F Amplifier Unit as follows:

(1) Set the receiver on its left side with bottom view visible.

(2) Disconnect the r-f cable from the Third I-F Amplifier Unit and disconnect the plug on the cable leading from the unit.

CAUTION

Do not pull on the cable. Grasp the plug and pull straight out.

(3) Loosen the four red-headed captive screws and remove the Third I-F Amplifier Unit from the receiver.

(4) Set the Third I-F Amplifier Unit on a support such as a small box, near enough such that the cables will reach their connectors on the receiver.

(5) Reconnect both the r-f cable and the input cable which were removed in step 4.f.(2).

(3) Turn the MICROVOLTS control full clockwise.

(4) Turn the % MODULATION control full counterclockwise.

(5) Turn the POWER ON-OFF switch to OFF.

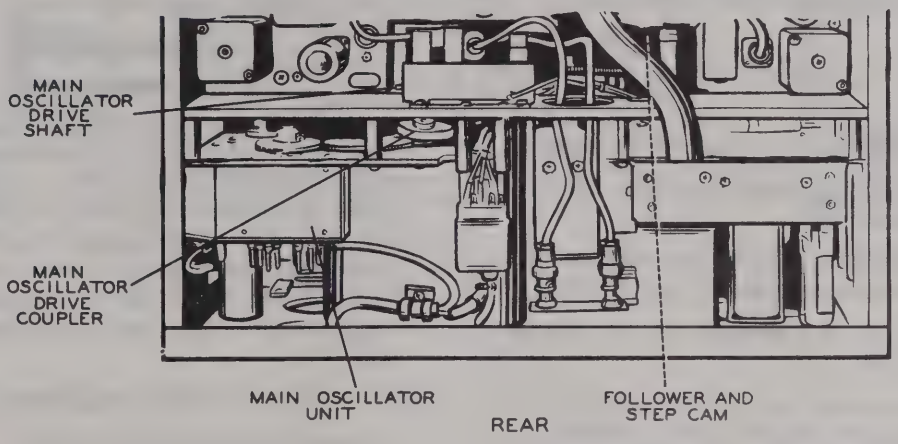


Figure 5-1. Radio Receiver R-278( )/GR, Partial Bottom View, Cover Removed

h. Remove tubes V-402 and V-404 from the First I-F Amplifier Unit.

i. Connect the Electronic Multimeter 410B as outlined below:

(1) Set the multimeter SELECTOR switch to -DC, the RANGE switch to 10V, and zero the meter.

(2) Insert the multimeter DC probe into J-606 and connect the meter common lead to the receiver chassis. See figure 5-2 for the location of the AVC receptacle, J-606.

j. Adjust and connect Signal Generator AN/URM-25( ) as follows:

(1) Connect the R.F. OUTPUT X-MULT receptacle (J-102) of the signal generator through a 50-ohm resistor to receptacle J-404 on the First I-F Amplifier chassis. Connect the shell of the output cable connector to any unpainted screw or nut on the amplifier chassis, using a convenient length of hook-up wire.

(2) Turn the CARRIER CONTROL full counterclockwise.

(6) Connect the power cable to input receptacle.

(7) Turn the POWER ON-OFF switch to ON. Allow 15 minutes warmup time.

(8) Check the meter switch for zero meter reading in all three positions. Place in RF position. On the D-Model generator, set the switch on CARRIER-CW.

(9) Set the FREQUENCY BAND SWITCH to band G. Use the 3.0-9.5, mc band on the D-Model signal generator.

(10) Set the CARRIER RANGE switch to the DEFG position or to the 230 KC-16 MC position. On the D-Model signal generator, set the CARRIER RANGE switch to the 300 KC-50 MC X MULT position.

(11) Rotate the frequency tuning dial to select at frequency of 9.5 megacycles.

(12) Adjust the CARRIER CONTROL or SET CARRIER Control for full-scale indication on the MICRO-VOLTS scale of the meter. Meter will indi-

cate 10, 50, or 100 depending on model of signal generator.

(13) Select the output MULTIPLIER switch to the 100 position.

(14) Set the MOD SELECTOR switch to OFF. This adjustment is not required on the D-Model signal generator.

k. Set the receiver controls as outlined below:

(1) Set the MAIN RF GAIN control to 10.

(2) Position the SQUELCH control to OFF.

(3) Set the AVC TIME CONSTANT COMM. - D/F switch to COMM.

(4) If testing an R-278/GR, set the AVC switch to ON.

(5) Set the CHANNEL SELECTOR to position 1.

(6) Set the three numbered CHANNEL switches to 229.5 mc on channel 1.

(7) Set the POWER ON-OFF switch to the ON position. Allow 15 minutes warmup time.

l. Align the Second I-F Amplifier Unit as outlined in the following steps:

(1) Rotate the signal generator frequency control around 9.5 mc and adjust the MICROVOLTS control until the multimeter indication is approximately 3.5 volts.

(2) Set the signal generator frequency control for the highest reading on the multimeter.

(3) Adjust the MICROVOLTS control of the signal generator for a reading of 3.5 volts as the highest reading.

(4) Using the nonmetallic screwdriver, adjust first the secondary and then the primary cores of T-502, and then the secondary and primary cores of T-501. Turn the signal generator MICROVOLTS control after each adjustment to maintain 3.5 volts as indicated on the multimeter for step (3) above.

NOTE

The core adjusting screws are visible in the holes marked "T-502 PRI-CORE SEC-CORE" and "T-501 PRI-CORE SEC-CORE" in figure 5-2.

m. Set the receiver POWER ON-OFF switch to OFF and disconnect all test equipment, cables, and hook-up wire.

n. Replace tubes V-402 and V-404 and replace the Third I-F Amplifier Unit on the receiver chassis.

o. Place the dust cover on the receiver, return the equipment to the mounting rack, and return the unit to its original condition.

5-33. ALIGNMENTS AND ADJUSTMENTS - RADIO RECEIVER R-278( )/GR FIRST I-F AMPLIFIER ALIGNMENT.

5-34. GENERAL INFORMATION.

a. The purpose of this routine is to align the First I-F Amplifier Unit of Radio Receiver R-278( )/GR.

b. The approximate time required to complete this alignment is one and three-quarter hours.

c. Allow the receiver to warm up for ten minutes before performing the procedure which follows in step 4.

WARNING

When the POWER ON-OFF switch on the receiver is turned "ON", high voltage is present on the exposed terminals. The receiver can be placed in a standby condition with only filament voltage applied by turning the TRACKING CONTROL switch to OFF. This switch, located at the rear of the receiver chassis, should be positioned to OFF before handling the equipment.

5-35. TEST EQUIPMENT REQUIRED.

a. Signal Generator AN/URM-25( ).

b. Electronic Multimeter 410B.

5-36. MATERIALS REQUIRED.

a. Slot Screwdriver.

b. Phillips Screwdriver. (No. 1 furnished with receiver).

c. Screwdriver, nonmetallic.

d. Headset, CW-49507.

e. Hook-up wire, No. 22 AWG, length as required.

f. Tuning Wand. (See figure 5-3).

g. Use iron core end of second tuning wand. (See figure 5-3).

(1) Secure core, item B of figure 5-3 to a handle similar to item D of figure 5-3.

h. Resistor, 50-ohm, one-half watt, carbon type.

i. CX-1174/U, Power Cable, or equivalent.

5-37. PROCEDURE.

a. Set the POWER ON-OFF switch on the front of Radio Receiver R-278( )/GR to the OFF position.

b. Disconnect all cables from the front of the receiver.

c. Remove the receiver from the rack, remove the

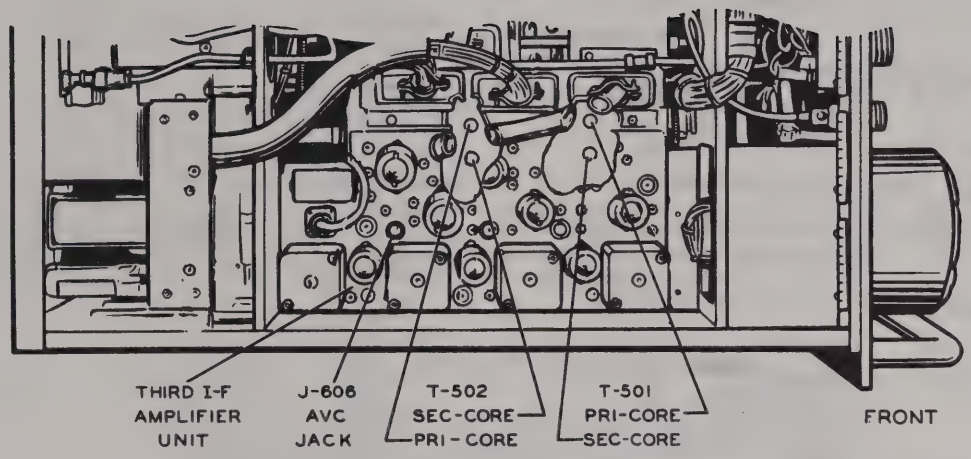


Figure 5-2. Radio Receiver R-278( )/GR, Partial Bottom View, Cover Removed

dust cover, and place the unit on a test bench.

d. Pull the interlock plunger at the rear of the unit to its full outward position and set the TRACKING CONTROL to NORMAL. The TRACKING CONTROL is located at the rear of the receiver chassis.

e. Connect an a-c power cable from an a-c power source to the 50-60 POWER connector on the front panel of the receiver.

f. Plug the headset into the PHONES receptacle on the front of the receiver.

g. Remove tube V-102 from the R-F Amplifier Unit and tube V-305 from the Frequency Multiplier-Amplifier Unit.

h. Adjust and connect Electronic Multimeter 410B in the following manner:

(1) Set the RANGE switch to 10V., set the SELECTOR switch to -DC, and zero the meter.

(2) Connect the DC probe of the multimeter to receptacle J-405, on the receiver.

(3) Connect the meter ground lead to any unpainted screw head or nut on the receiver chassis.

i. Set the receiver controls as outlined below:

(1) Set the MAIN RF GAIN to 10.

(2) Set the SQUELCH switch to OFF.

(3) Position the AVC TIME CONSTANT COMM. D/F switch to COMM.

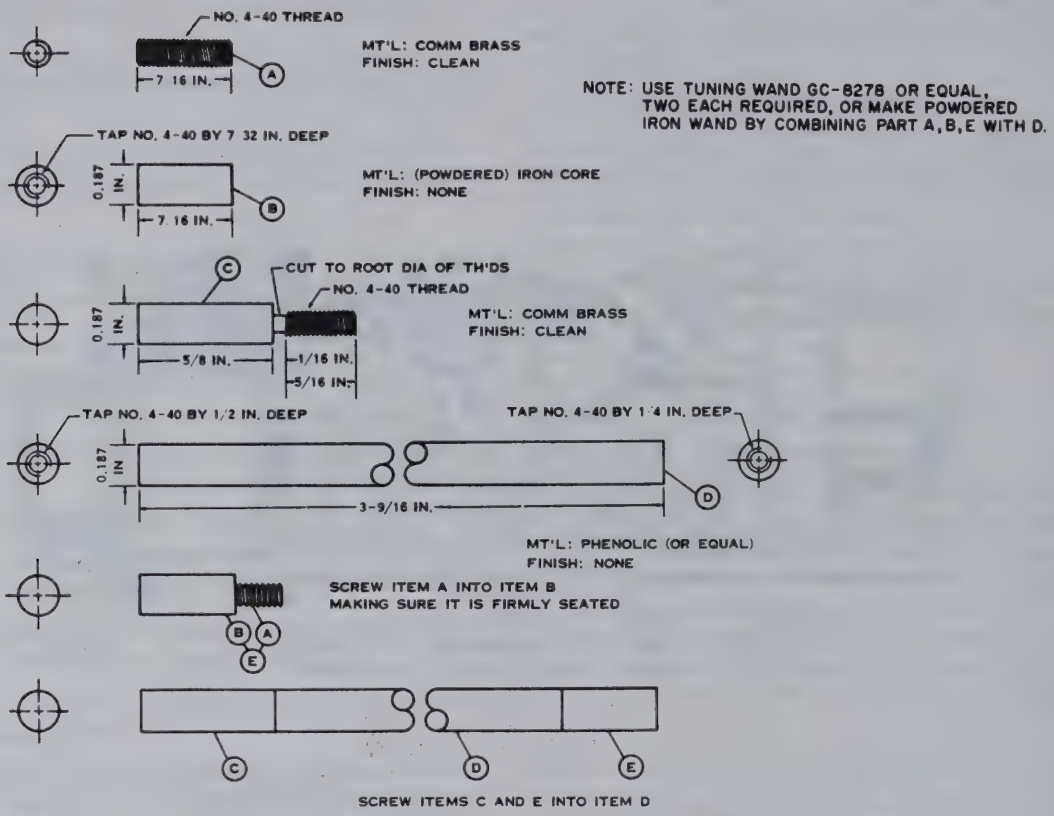


Figure 5-3. Tuning Wand Fabrication Details

(4) If testing an R-278/GR, set the AVC switch to ON.

(5) Set the receiver on its right side, and recheck all settings of the receiver.

(6) Set the CHANNEL SELECTOR to 1 and set the POWER ON-OFF switch to ON.

j. Align the second oscillator tank circuit, T-403, of the First I-F Amplifier Unit as follows:

NOTE

The trimmer and core adjusting screws referred to in this step can be reached through the holes marked "T-403 PRI-TRIM SEC-CORE," "T-402 SEC-TRIM PRI-CORE" and so forth as illustrated in figure 5-4.

(1) Set the three numbered CHANNEL switches to 229.0 mc in channel 1.

(2) Using a nonmetallic screwdriver, adjust the "T-403 PRI-TRIM" for maximum indication on the multimeter. Record this reading. See figure 5-4 for location of "T-403 PRI-TRIM".

(3) Set the three numbered CHANNEL switches on the receiver to 220.0 mc on channel 1.

(4) Adjust the "T-403 PRI-CORE" for a maximum indication on the multimeter. Record this reading.

(5) Repeat steps (1) through (4) until no further meter increase can be obtained over those recorded readings in steps (2) and (4).

(6) Disconnect the plug from connector J-505. Connector J-505 is located on the Second I-F Amplifier Unit.

(7) Disconnect the multimeter DC probe from J-405 and connect it to J-404.

(8) Set the three numbered CHANNEL switches to 229.0 mc on channel 1.

(9) Adjust the secondary trimmer of T-403 for a maximum multimeter indication and record the reading. See figure 5-4 for the location of "T-403 SEC-TRIM".

(10) Set the three numbered CHANNEL switches to 220.0 mc on channel 1.

(11) Adjust "T-403 SEC-CORE" as shown in figure 5-4 for a maximum multimeter indication and record this reading.

(12) Set the three numbered CHANNEL switches to 229.0 mc on channel 1.

(13) Repeat steps (1), (9), (3) and (11) until no further increase can be obtained over the readings re-

corded in steps (9) and (11).

(14) Set the three numbered CHANNEL switches to 229.0 mc and check the alignment as follows:

(a) Locate the hole in can T-403 which is nearest the front panel of the receiver and insert first the brass end of the tuning wand and then the iron end of the wand. Note the multimeter reading.

(b) Insert the brass end of the tuning wand, and then the iron end of the wand into the opposite hole in T-403.

(c) Repeat steps (a) and (b) above at the other nine settings of the one-megacycle frequency selector switch. If the multimeter readings increase no more than 0.5 volts in steps (a), (b) or (c), the oscillator is aligned properly. Proceed to step k. However, if the meter readings increase more than 0.5 volt, perform the following steps:

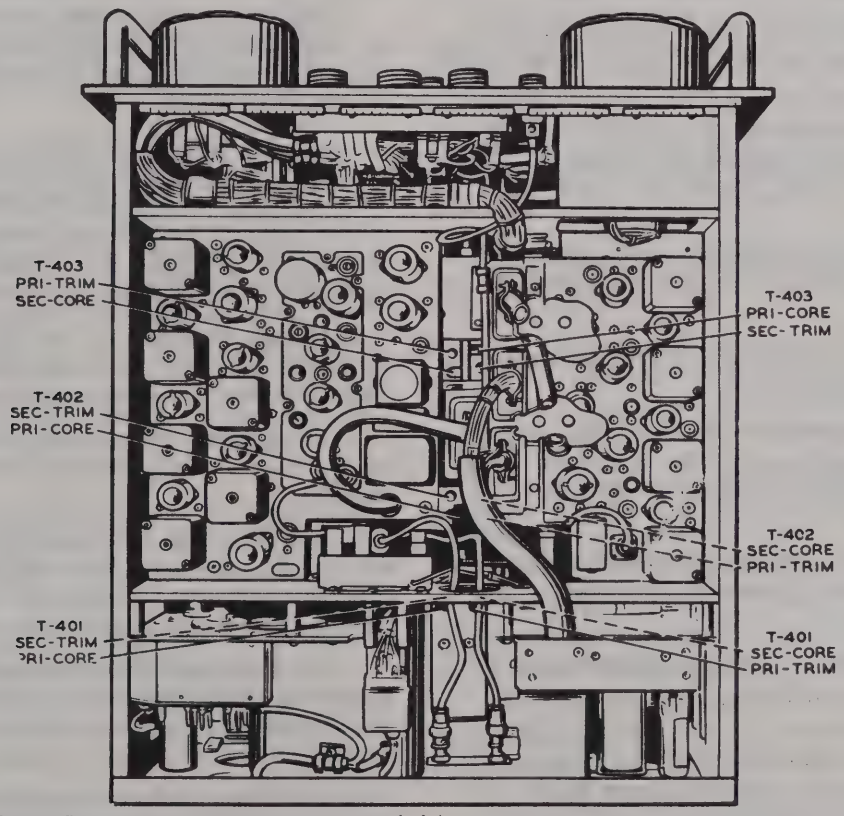


Figure 5-4. Radio Receiver R-278( )/GR, Bottom View, Cover Removed

(d) Disconnect the multimeter DC probe from J-404 and connect it to J-405.

(e) Connect the plug to J-505 on the Second I-F Amplifier Unit.

(f) Repeat steps 4.j.(1) through 4.j.(14) as required.

k. Connect the plug to connector J-505 on the Second I-F Amplifier.

l. Disconnect the multimeter DC probe from J-404 and connect it to the AVC receptacle, J-606. (Located on the 3rd I-F Amplifier Unit).

m. Connect and adjust Signal Generator AN/URM-25( ) as outlined below:

(1) Turn the CARRIER CONTROL full counterclockwise.

(2) Turn the MICROVOLTS control full clockwise.

(3) Turn the % MODULATION control full counterclockwise.

(4) Turn the POWER ON-OFF switch to OFF.

(5) Connect the power cable to input receptacle.

(6) Turn the POWER ON-OFF switch to ON. Allow 15 minutes warmup time.

(7) Check the meter switch for zero meter reading in all three positions. Place in RF position.

(8) Set the FREQUENCY BAND SWITCH to band H. Use the 30-50 mc bank on the D-Model Signal Generator.

(9) Set the CARRIER RANGE switch to band H.

(10) Rotate the frequency tuning dial to select at frequency of 45.0 megacycles.

(11) Connect the R.F. OUTPUT X-MULT receptacle (J-102) of the signal generator through a 50-ohm

resistor to receptacle J-402 on the First I-F Amplifier Unit. Connect the shell of the signal generator OUTPUT connector to a grounded screw head or nut on the receiver chassis, using a convenient length of hookup wire.

(12) Set the CARRIER CONTROL or SET CARRIER control for full-scale indication on the MICROVOLTS scale of the meter. Meter will indicate 10, 50, or 100 depending on the model of signal generator.

(13) Select the RF MULTIPLIER switch to the 100 position.

(14) Set the MOD SELECTOR switch to OFF.

n. Align the trimmers of T-401 and T-402 as follows:

(1) Set the three numbered CHANNEL switches on the receiver to 225.0 mc.

(2) Adjust the signal generator MICROVOLTS control for a multimeter indication of 3.5 volts.

(3) Locate the hole on top of T-401 which is nearest the rear of the receiver and insert the powdered iron slug.

(4). Adjust the secondary trimmer of T-401 for maximum reading as indicated on the multimeter. The secondary trimmer of T-401 is labeled "T-401 SEC-TRIM" in figure 5-4.

(5) Adjust the signal generator MICROVOLTS control for a reading of 3.5 volts as indicated on the multimeter.

(6) Remove the powdered iron slug and insert it into the opposite hole of T-401.

(7) Adjust the primary trimmer of T-401 for a maximum reading as indicated on the multimeter. The primary trimmer of T-401 is labeled "T-401 PRI-TRIM" in figure 5-4.

(8) Adjust the signal generator MICROVOLTS control for a reading of 3.5 volts as indicated by the multimeter.

(9) Remove powdered iron slug from T-401 and insert it into the hole in T-402 which is nearer the end of the receiver.

(10) Adjust "T-402 SEC-TRIM" for a maximum reading on the multimeter. Refer to figure 5-1 for the location of "T-402 SEC-TRIM."

(11) Adjust the signal generator MICROVOLTS control for a reading of 3.5 volts as indicated by the multimeter.

(12) Remove the slug and insert it into the other hole in T-402.

(13) Adjust "T-402 PRI-TRIM" until a maximum meter indication is obtained.

(14) Remove the powdered iron slug.

o. Align tank circuits T-401 and T-402, of the First I-F Amplifier Unit as follows:

(1) Set the three numbered CHANNEL switches to 220.0 mc in the same unused channel.

(2) Set the signal generator frequency control at 40.0 mc and set the MICROVOLTS control for a 3.5 volt reading on the multimeter.

(3) Insert the powdered iron slug into the hole in the top of T-401 which is nearer the rear of the receiver.

(4) Insert first the brass end of the tuning wand, and then the iron end of the wand in and out of the other hole in T-401. Observe any change in the meter reading as indicated by the multimeter.

(5) If the multimeter reading decreases when either end of the tuning wand is inserted, the can is properly aligned. If the iron end causes an increase of less than 0.5 volt, the can is aligned properly.

(6) If the meter reading increases when the brass end is inserted, or if the reading increases more than 0.5 volt when the iron end is inserted, adjust the tuning coils as follows:

(a) If the brass end increased the meter reading, turn the "T-401 SEC-CORE" adjustment one-half turn in a counterclockwise direction.

(b) If the iron end increased the reading more than 0.5 volt, turn the "T-401 SEC-CORE" adjustment one-half turn in a clockwise direction.

(c) Repeat steps (4), (5) and (6) until the multimeter indicates a decrease when the brass end of the tuning wand is inserted into T-401.

(7) Remove the powdered iron slug and insert it into the hole in T-401 which is nearer the front of the receiver.

(8) Insert first the brass end of the tuning wand, and then the iron end of the wand in and out of the other hole in T-401. Observe any change in the meter reading as indicated by the multimeter.

(9) If the multimeter reading decreases when either end of the tuning wand is inserted, the can is properly aligned. If the iron end causes an increase of less than 0.5 volt, the can is aligned properly.

(10) If the meter reading increases when the brass end is inserted, or if the reading increases more than 0.5 volt when the iron end is inserted, adjust the tuning coils as follows:

(a) If the brass end increased the meter reading, turn the "T-401 PRI-CORE" adjustment one-half turn in a counterclockwise direction.

(b) If the iron end increased the reading more than 0.5 volt, turn the "T-401 PRI-CORE" adjustment one-half turn in a clockwise direction.

(c) Repeat steps (8), (9) and (10) until the multimeter indicates a decrease when the brass end of

the tuning wand is inserted into T-401, and an increase of less than 0.5 volt when the iron end of the wand is inserted into T-401.

(11) Remove the powdered iron slug from T-401 and insert it into the hole in T-402 which is nearer the rear of the receiver.

(12) Insert first the brass end of the wand, and then the iron end of the wand in and out of the hole in T-402. Observe any change in the multimeter reading.

(13) If the multimeter reading decreases when either end of the tuning wand is inserted, the can in properly aligned. If the iron end of the wand causes an increase of less than 0.5 volt, the can is properly aligned.

(14) If the multimeter reading increases when the brass end of the wand is inserted, or if the reading increases more than 0.5 volt when the iron end is inserted, adjust the tuning coils as follows:

(a) If the brass end increased the multimeter reading, turn the "T-402 SEC-CORE" adjustment, as shown in figure 5-4, one-half turn in a counterclockwise direction.

(b) If the iron end increased the meter reading more than 0.5 volt, turn the "T-402 SEC-CORE" adjustment one-half turn in a clockwise direction.

(c) Repeat steps (12), (13) and (14) until the multimeter indicates a decrease when the brass end of the wand is inserted into T-402 and an increase of less than 0.5 volt when the iron end of the wand is inserted into T-402.

(15) Remove the powdered iron core from the hole in T-402 and insert it into the hole in T-402 which is nearer the front of the receiver.

(16) Insert first the brass end of the tuning wand, and then the iron end of the tuning wand in and out of the hole in T-402. Observe any change in the multimeter reading.

(17) If the multimeter reading decreases when either end of the tuning wand is inserted, the can is properly aligned. If the iron end of the wand causes an increase of less than 0.5 volt, the can is properly aligned.

(18) If the multimeter reading increases when the brass end of the wand is inserted, or if the reading increases more than 0.5 volt when the iron end is inserted, adjust the tuning coils as follows:

(a) If the brass end increased the multimeter reading, turn "T-402 PRI-CORE" adjustment one-half turn in a counterclockwise direction.

(b) If the iron end increased the meter reading more than 0.5 volt, turn the "T-402 PRI-CORE" adjustment one-half turn in a clockwise direction.

(c) Repeat steps (16), (17) and (18) until the multimeter indicates a decrease when the brass end of the tuning wand is inserted into T-402, and an increase of less than 0.5 volt when the iron end of the wand is inserted into T-402.

(19) Remove the powdered iron slug from T-402.

(20) Set the three numbered CHANNEL switches to 229.9 mc.

(21) Position the signal generator frequency control to 49.9 mc and set the MICROVOLTS control for a 3.5 volt meter indication on the multimeter.

(22) Insert the powdered iron slug into the hole in the top of T-401 which is nearer the rear of the receiver.

(23) Pass first the brass end and then the iron end of the tuning wand in and out of the other hole in T-401. Observe any change in the multimeter indication.

(24) If the meter reading decreases with either end of the tuning wand inserted, or if the insertion of the iron end increases the reading by less than 0.5 volt, the trimmer is correctly adjusted.

(25) If the conditions of step (24) are not met, adjust "T-401 SEC-TRIM" until a maximum indication is obtained on the multimeter.

(26) Remove the powdered iron slug and insert it into the hole in the top of T-401 which is nearer the front of the receiver.

(27) Pass first the brass end of the tuning wand and then the iron end of the wand in and out of the other hole in T-401. Observe any change in the meter reading as indicated on the multimeter.

(28) If the multimeter reading decreases with each end of the tuning wand inserted, or if insertion of the iron end increases the meter reading by less than 0.5 volt, the trimmer is properly aligned.

(29) If the conditions of step (28) are not met, adjust "T-401 PRI-TRIM" as shown in figure 5-4 for a maximum indication on the multimeter.

(30) Remove the slug from T-401 and insert it into the hole in T-402 which is nearer the rear of the receiver.

(31) Pass first the brass end and then the iron end of the tuning wand into the other hole in T-402. Observe any change in the multimeter indication.

(32) If the multimeter reading decreases with each end of the tuning wand inserted, or if insertion of the iron end increases by less than 0.5 volt, the trimmer is properly adjusted.

(33) If the meter indicates an increase of more than 0.5 volt with the insertion of the iron end of the tuning wand, or if the meter indicates any increase with the insertion of the brass end of the wand, ad-

just the "T-402 SEC-TRIM" until maximum reading is obtained on the multimeter.

(34) Remove the iron core and insert it into the hole in T-402 which is nearer the front of the receiver.

(35) Pass first the brass end and then the iron end of the tuning wand in and out of the other hole in T-402. Observe any change in the meter indication on the multimeter.

(36) If the multimeter reading decreases with either end of the tuning wand inserted, or if the iron end causes the meter reading to increase less than 0.5 volt, the trimmer is adjusted properly.

(37) If the conditions as stated in step (36) are not true, adjust "T-402 PRI-TRIM" until a maximum reading is obtained on the meter.

(38) Remove the powdered iron core and repeat steps 4.o.(1) through 4.o.(37) until no further improvement is obtained.

p. Turn the receiver POWER ON-OFF switch to the OFF position.

q. Disconnect all cables and test equipment.

r. Replace the dust cover on the receiver and return the equipment to its original condition.

5-38. ALIGNMENTS AND ADJUSTMENTS OF RADIO RECEIVER R-278( )/GR MAIN OSCILLATOR ALIGNMENT.

5-39. GENERAL INFORMATION.

a. The purpose of this routine is to align the Main Oscillator Unit of Radio Receiver R-278( )/GR.

b. The time required to complete this alignment is approximately 45 minutes.

c. A ten-minute warmup period is necessary prior to aligning the Main Oscillator.

WARNING

When the POWER ON-OFF switch on the receiver is in the ON position, high voltage is present on the exposed contacts. The receiver can be placed in a standby condition, with only filament voltage applied, by setting the TRACKING CONTROL switch to the OFF position. The TRACKING CONTROL switch, located at the rear of the receiver chassis, should be set to OFF before handling the equipment.

d. Each tuning coil adjusting screw on the Main Oscillator Unit is numbered to correspond with the left-hand CHANNEL switch located behind the front panel door. Example: Coil adjusting screw numbered 22 corresponds to the extreme left CHANNEL switch setting of 22.

5-40. TEST EQUIPMENT REQUIRED.

a. Electronic Multimeter 410B.

5-41. MATERIALS REQUIRED.

a. CX-1174/ U Power Cable, or equivalent.

b. Slot screwdriver.

c. Headset CW-49507.

d. Screwdriver, nonmetallic.

5-42. PROCEDURE.

a. Set the POWER ON-OFF switch on Radio Receiver R-278( )/GR to the OFF position.

b. Disconnect all cables from the front of the receiver.

c. Remove the receiver from the mounting rack, remove the dust cover, and place the unit on a work bench.

d. Remove the rear frame plate from the receiver and locate the coil adjusting screws at the lower right corner of the equipment. See figure 5-5.

e. Connect the a-c power cable between an a-c power receptacle and the 50-60 ∿ POWER connector on the front of the receiver.

f. Plug the headset into the PHONES receptacle on the front of the receiver.

g. Pull the interlock plunger at the rear of the receiver to its full outward position and set the TRACKING CONTROL switch to NORMAL.

h. Adjust and connect Electronic Multimeter 410B in the following manner:

(1) Set the SELECTOR switch to DC.

(2) Position the RANGE switch to the 3V setting and zero the meter.

(3) Attach the DC probe at C-302 TEST POINT. Refer to figure 5-5 for the location of C-302 TEST POINT.

(4) Connect the multimeter common lead to the receiver chassis.

i. Set the receiver POWER ON-OFF switch to ON.

j. Align the oscillator coils as follows:

(1) Set the CHANNEL SELECTOR switch to position 1.

(2) Set the three numbered CHANNEL switches to 395.0 mc on channel 1.

(3) Turn the coil adjusting screw numbered 39 all the way in flush with the stud slot and then back it out until the multimeter indicates a maximum meter reading.

(4) Set the TRACKING CONTROL from NORMAL to OFF and back to NORMAL. The multimeter indication should return. If the reading returns, proceed to

step k. If the reading does not return, perform step (5).

(5) Turn the coil adjusting screw in a counterclockwise direction until the meter reading returns then turn the screw 1/8 turn counterclockwise. The meter reading should not be less than 0.55 volt. If the reading does not return, or if the voltage is less than 0.55 volt, notify the supervisor.

k. Set the three numbered CHANNEL switches to the frequencies listed in steps (1) through (17) below and adjust the corresponding coil adjusting screws for a maximum meter reading. After each CHANNEL switch setting, adjust the appropriate coil adjusting screw in the manner given in steps 4.j.(3) and (4).

(1) 385.0 mc, screw number 38.

(2) 375.0 mc, screw number 37.

(3) 365.0 mc, screw number 36.

(4) 355.0 mc, screw number 35.

(5) 345.0 mc, screw number 34.

(6) 335.0 mc, screw number 33.

(7) 325.0 mc, screw number 32.

(8) 315.0 mc, screw number 31.

(9) 305.0 mc, screw number 30.

(10) 295.0 mc, screw number 29.

(11) 285.0 mc, screw number 28.

(12) 275.0 mc, screw number 27.

(13) 265.0 mc, screw number 26.

(14) 255.0 mc, screw number 25.

(15) 245.0 mc, screw number 24.

(16) 235.0 mc, screw number 23.

(17) 225.0 mc, screw number 22.

l. Turn the receiver POWER ON-OFF switch to OFF.

m. Disconnect all cables and test equipment.

n. Replace the rear plate on the receiver.

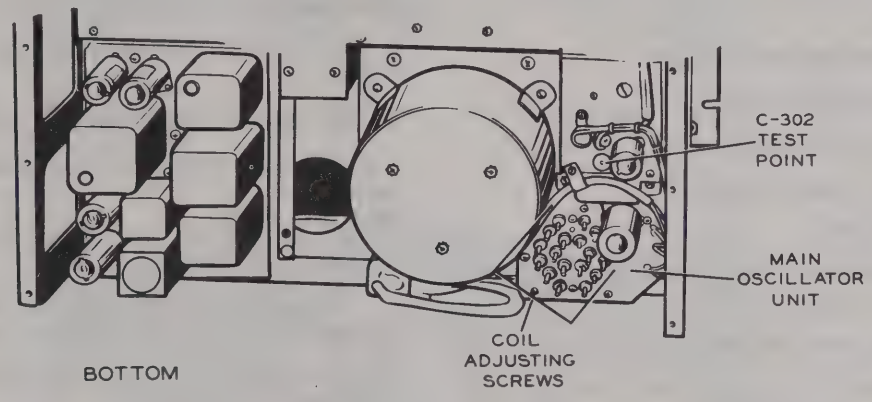


Figure 5-5. **Radio Receiver R-278( )/GR, Partial Rear View, Cover Removed**

o. Replace the dust cover, place the receiver in the mounting rack, and return the equipment to its original condition.

5-43. ALIGNMENTS AND ADJUSTMENTS OF RADIO RECEIVER R-278( )/GR FREQUENCY MULTIPLIER-AMPLIFIER ALIGNMENT.

5-44. GENERAL INFORMATION.

a. The purpose of this routine is to align the Frequency Multiplier-Amplifier Unit of Radio Receiver R-278( )/GR.

b. The approximate time required to complete this procedure is one and one-quarter hours.

c. For this routine, it is assumed that the Main Oscillator Unit is correctly aligned, and that the gearing to the Frequency Selector Unit is properly synchronized.

d. Allow a ten-minute warmup period before attempting this receiver alignment.

WARNING

When the POWER ON-OFF switch on the receiver is in the ON position, high voltage is present on the exposed terminals. The high voltage can be removed by setting the TRACKING CONTROL switch, located at the rear of the receiver chassis, to the OFF position. Before handling this equipment, set the TRACKING CONTROL switch to OFF; also turn tracking switch to the OFF position while connecting multimeter to the receiver for the following tests.

5-45. TEST EQUIPMENT REQUIRED.

a. Electronic Multimeter 410B.

5-46. MATERIALS REQUIRED.

a. Tuning Wand. Refer to figure 5-3.

b. Headset, CW-49507.

c. Sector Bending Tool, made from a blunt scriber with the sides ground flat.

d. Trouble Light, penlight type.

e. Slot Screwdriver.

f. Screwdriver, nonmetallic.

g. Resistor, 470,000 ohms, one-half watt, carbon type.

h. Hookup wire, length as required.

i. CX-1174/U Power Cable, or equivalent.

5-47. PROCEDURE.

a. Set the POWER ON-OFF switch on Radio Receiver R-278( )/GR to the OFF position.

b. Disconnect all cables from the front of the receiver and remove it from the rack.

c. Remove the dust cover and place the receiver on a work bench.

d. Remove the rear frame plate from the end of the chassis so that trimmers Z-301, Z-303, Z-305, Z-307 and Z-309 are accessible. Refer to figure 5-6 for the location of these trimmers.

e. Connect the power cable between the 50-60 ∿ power receptacle located on the front panel and an a-c power outlet.

f. Plug the headset into the PHONES receptacle located on the front panel.

g. Pull the interlock plunger at the rear of the receiver chassis to its full outward position and set the TRACKING CONTROL switch to NORMAL.

h. Remove the screws from the Frequency Multiplier-Amplifier end cover plate on the left side of the receiver chassis but leave the cover in place.

i. Adjust and connect Electronic Multimeter 410B to the receiver as follows:

(1) Position the RANGE switch to 10V, the SELECTOR switch to DC, and zero the meter.

(2) Connect the DC probe to capacitor C-309. Refer to figure 5-7 for the location of C-309.

(3) Connect the multimeter common lead to the receiver chassis.

j. Set up the receiver controls as outlined in the following steps:

(1) Position the CHANNEL SELECTOR switch to 1.

(2) Set the POWER ON-OFF switch to ON.

k. Align trimmer Z-301 as outlined in the following steps:

(1) Set the three numbered CHANNEL switches to 320.0 mc on channel 1.

(2) Adjust the Z-301 trimmer, figure 5-6, until the multimeter meter indication is maximum.

(3) Set the three numbered CHANNEL switches to 390.0 mc on channel 1.

(4) Slide the end cover plate upward far enough to insert first the brass end of the tuning wand and then the iron end of the wand close to the coil visible under the cover. Observe the multimeter indication. If the multimeter reading increased when the brass end of the wand was inserted, turn the TRACKING CONTROL to OFF, stretch the coil slightly to spread the turns, and then turn the TRACKING CONTROL to NORMAL. If the multimeter reading increased when the iron end of the tuning wand was inserted, turn the TRACKING CONTROL to OFF, compress the coil to bring the turns closer together, and turn the TRACKING CONTROL to NORMAL.

(5) Set the three numbered CHANNEL switches to 320.0 mc on channel 1.

(6) Repeat step (2).

(7) Set the three numbered CHANNEL switches to 390.0 mc on channel 1 and repeat step (4).

(8) Repeat steps (1) through (7) until a minimum tuning difference occurs between the frequency settings 320.0 mc and 390.0 mc.

l. Secure the side cover plate.

m. Align trimmers Z-303, Z-305, Z-307, and Z-309 as outlined below. See figure 5-6.

(1) Set the three numbered CHANNEL switches to 380.0 mc on channel 1.

(2) Disconnect the multimeter DC probe from

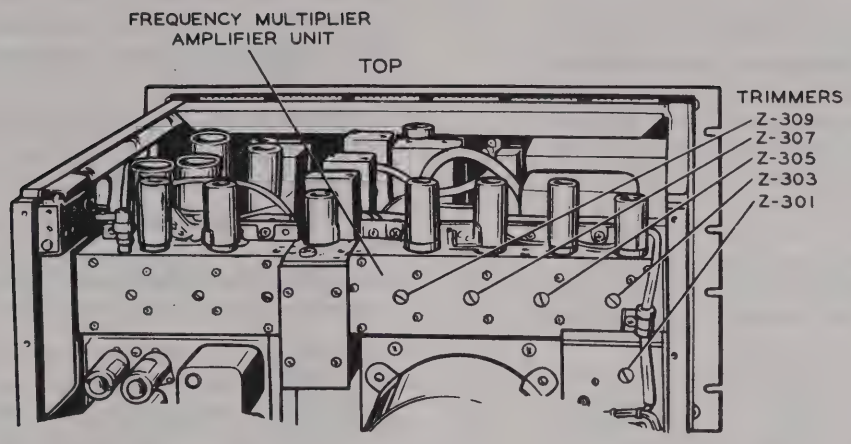


Figure 5-6. Radio Receiver R-278( )/GR, Partial Rear View, Cover Removed

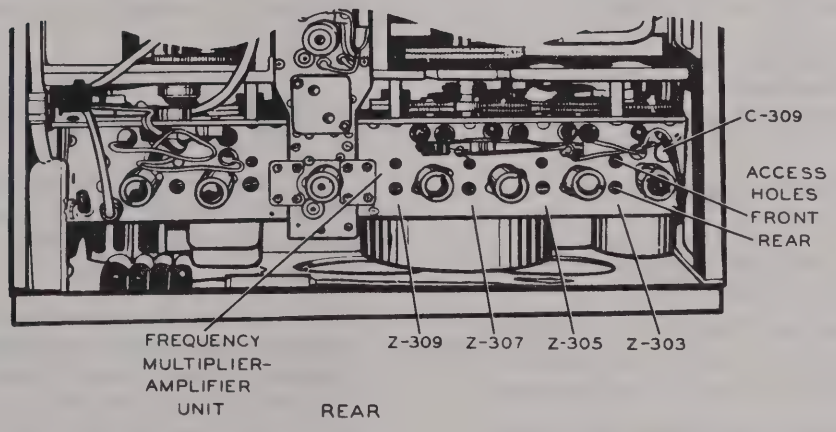


Figure 5-7. Radio Receiver R-278( )/GR, Partial Top View, Cover Removed

C-309 and set the multimeter SELECTOR switch to AC.

(3) Remove tube V-303 and connect the multimeter AC PROBE to pin 2 of XV-303. Common lead was grounded in step 4.i.(3).

(4) Adjust trimmer Z-303 until a maximum reading is obtained on the multimeter.

(5) Remove the AC PROBE from XV-303, replace V-303 in its tube socket, remove V-304, and connect the AC PROBE to pin 2 of XV-304.

(6) Adjust Z-305 for a maximum meter indication.

(7) Remove the AC PROBE from XV-304, replace V304 in the tube socket, remove V-305, and connect the AC PROBE to pin 2 of XV-305.

(8) Adjust trimmer Z-307 until the reading on 410B is maximum.

(9) Remove the AC PROBE from XV-305 and replace V-305 in the tube socket.

(10) Set the multimeter SELECTOR switch to -DC, zero the meter, and connect one lead of the 470,000-ohm resistor to the DC probe of the multimeter.

(11) Connect the other resistor lead to J-402 using a convenient length of hookup wire. J-402 is located on the First I-F Amplifier Unit.

(12) Adjust trimmer Z-309 until the multimeter indicates maximum.

(13) With the equipment in its present condition, repeat steps (4), (6), (8), and (12).

n. Align the Z-303, Z-305, Z-307, and Z-309 r-f tuning capacitors as follows:

NOTE

The tuning capacitors consist of two stator plates and three rotor plates, the front and rear rotor plates being radially slotted into sectors which can be bent closer or farther away from the adjacent stator plates. Refer to figure 5-6. These plates are visible in the Z-303, Z-305, Z-307, and Z-309 rear access holes as shown in figure 5-7. The tuning capacitors are aligned by bending the front or rear sector of rotor plates which are half engaged at the frequency under consideration.

In order to locate the proper sector, each is numbered and color coded. In order that the proper sector can be reached in the access hole, the TRACKING CONTROL switch is positioned to RUN, long enough to drive the gear behind the 10 MC INDICATOR DIAL (see figure 5-7) so the proper number or letter on the gear lines up with the mark on the dial.
The table in this step lists the sector color code, the number, and also the dial position required for each setting of the CHANNEL switches.

380.0 mc is the tuner tracking point, at which there is no sector.

(1) Set the three numbered CHANNEL switches to the first setting given in table XIII.

(2) Insert first the brass end of the tuning wand and then the iron end of the wand into the front access hole of Z-303. Observe the multimeter reading.

(3) If the meter reading decreased when either end was inserted into the hole, the tuner is aligned properly and no adjustment is necessary. If the meter reading increased when either end was inserted, proceed as follows:

(a) Set the TRACKING CONTROL switch to RUN, long enough to position the 10 MC INDICATOR DIAL to the setting listed in table XIII.

(b) Using a penlight type flashlight, look through the rear access hole of Z-303 and determine the sector color. The Sector Column of table XIII will aid in determining the proper sector.

(c) If the multimeter reading increased when the brass end was inserted into the front access hole, bend the sector away from the adjacent capacitor stator plate. Use the sector bending tool and bend the sector only a small amount.

(d) If the multimeter reading increased when the iron end was inserted in tuner Z-303, bend the sector closer to the adjacent capacitor stator plate. Use the sector bending tool and bend the sector only a small amount.

(e) Set the TRACKING CONTROL switch to NORMAL and repeat steps (2) and (3) for tuners Z-305, Z-307, and Z-309.

(f) Steps (2) and (3) shall be repeated until insertion of either end of the tuning wand causes a decrease in the multimeter reading.

NOTE

There may be some interaction between tuners so that bending the sector in one tuner may affect another. There will also be interaction between adjacent sectors of the same tuner so that close tracking

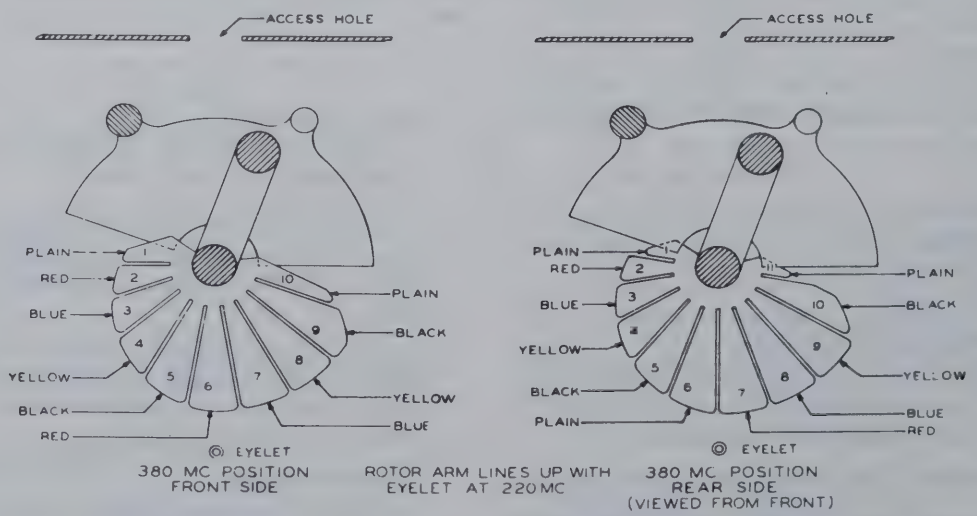


Figure 5-8. Radio Receiver R-278( )/GR, Frequency Multiplier-Amplifier Unit, Tuner Capacitor Sectors

can be accomplished only if the entire alignment procedure is repeated at least once.

(4) Set the three numbered CHANNEL switches on the receiver to the other settings given in table XIII, and perform steps (2) and (3) for each frequency setting.

NOTE

When the POWER ON-OFF switch on the receiver is in the ON position, high voltage is present on the exposed terminals. The high voltage can be removed by setting the TRACKING CONTROL switch, located at the rear of the chassis, to the OFF position. Before handling the equipment, it is suggested that this switch be turned "OFF".

TABLE XIII. FREQUENCY MULTIPLIER-AMPLIFIER ALIGNMENT POINTS

CHANNEL SWITCH SETTINGS	INDICATION DIAL POSITION	SECTOR	
		NUMBER*	COLOR
390.0	I	10 - Front	Plain
370.0	30	1 - Front	Plain
360.0	29	2 - Back	Red
350.0	28	2 - Front	Red
340.0	27	3 - Back	Blue
330.0	26	3 - Front	Blue
320.0	25	4 - Back	Yellow
310.0	24	4 - Front	Yellow
300.0	23	5 - Back	Black
290.0	22	5 - Front	Black
280.0	A	6 - Back	Plain
270.0	B	6 - Front	Red
260.0	C	7 - Back	Red
250.0	D	7 - Front	Blue
240.0	E	8 - Back	Blue
230.0	F	8 - Front	Yellow
220.0	G	9 - Back	Yellow

*Back indicates rotor plate next to ceramic end plate. Front indicates rotor plate toward drive shaft.

o. Set the TRACKING CONTROL switch to NORMAL, set the receiver POWER ON-OFF switch to OFF, and disconnect all cables from the equipment.

p. Disconnect the test equipment and replace the receiver dust cover.

q. Place the receiver in the mounting rack and return the equipment to its original condition.

5-48. ALIGNMENTS AND ADJUSTMENTS OF RADIO RECEIVER R-278( )/GR R-F AMPLIFIER ALIGNMENT.

5-49. GENERAL INFORMATION.

a. The purpose of this routine is to describe the procedures for adjustment of the R-F Amplifier Unit of Radio Receiver R-278( )/GR.

b. The approximate time necessary for the completion of this routine is three hours.

c. Allow a ten-minute warmup period before attempting this receiver alignment.

5-50. TEST EQUIPMENT REQUIRED.

a. Electronic Multimeter 410B.

b. Signal Generator AN/URM-44.

5-51. MATERIALS REQUIRED.

a. Screwdriver, nonmetallic.

b. Phillips head Screwdriver.

c. Sector Bending Tool, made from a blunt scriber with the sides ground flat.

d. Tuning Wand. See figure 5-3.

e. CX-1174/U Power Cable, or equivalent.

f. CG-690/U Coaxial Cable, or equivalent.

g. Trouble Light, penlight type.

h. Slot Screwdriver.

5-52. PROCEDURE.

a. Set the receiver POWER ON-OFF switch to the OFF position.

b. Disconnect all cables from the front of the receiver and remove the receiver from the mounting rack.

c. Remove the dust cover and place the receiver on a test bench.

d. Pull the interlock plunger on the rear of the receiver chassis to its full outward position.

e. Set the Electronic Multimeter 410B SELECTOR switch to DC, the RANGE switch to 10 volts and zero the meter.

f. Connect the multimeter DC probe to receptacle J-606 located on the Third I-F Amplifier Unit. Refer to figure 5-9.

(4) Connect the RG-8/U coaxial cable from the signal generator OUTPUT jack to the ANTENNA jack on the front of the receiver.

(5) Adjust the AMP. TRIMMER control on the signal generator until the OUTPUT VOLTS meter indicates a peak. It may be necessary to adjust the output by turning the OUTPUT LEVEL control to keep the meter indication within the range of the AMP. TRIMMER control.

(6) Adjust the OUTPUT LEVEL control until the pointer on the OUTPUT VOLTS meter rises or falls to the SET LEVEL line.

(7) Set the attenuator control to 90 on the DBM scale.

i. Connect an a-c cable from the primary power outlet to the 50-60 POWER receptacle on the receiver.

j. Set the receiver POWER ON-OFF switch to the ON position.

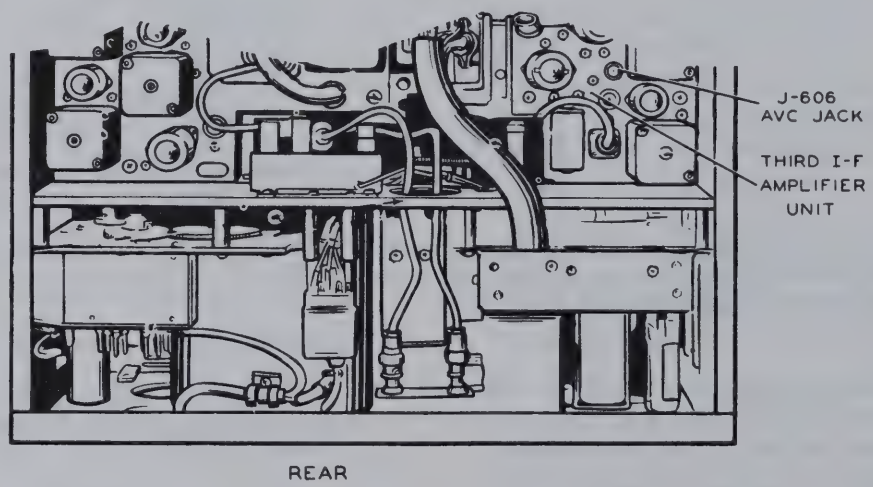


Figure 5-9. Radio Receiver R-278( )/GR, Partial Bottom View, Cover Removed

g. Connect the ground lead to the multimeter to receiver chassis ground.

h. Adjust and connect Signal Generator AN/USM-44 to the receiver as described in the following steps:

(1) Attach the a-c power cable to the signal generator and set the ON-OFF switch to the ON position.

(2) Set the FREQUENCY RANGE knob to E and the MOD. SELECTOR switch to CW.

(3) Adjust the FREQUENCY CONTROL knob to approximately 360.0 mc as indicated on the E scale of the MEGACYCLES dial.

k. Rotate the CHANNEL SELECTOR on the receiver to an unused channel and set the MAIN RF GAIN to 10.

l. Set the three numbered CHANNEL switches on the receiver to 360.5 mc on the same unused channel.

m. Adjust the FREQUENCY CONTROL on the signal generator until the multimeter indicates a maximum reading.

n. Repeat steps 4.h.(5) and (6).

o. Adjust the attenuator control of the signal generator until the multimeter indication is 3.5 volts.

Adjust attenuator control to 3.5V reading after each check and adjustment before further adjustments are made.

p. Adjust trimmers Z-101, Z-102, and Z-103, in this order, for a maximum multimeter reading. See figure 5-10 for location of Z-101, Z-102, and Z-103.

q. Perform testing and sector adjustment of r-f tuners Z-101, Z-102, and Z-103 in the following manner:

(1) Set the three numbered CHANNEL switches on the receiver to 365.5 mc on the same channel selected in step 4.k.

(2) Adjust the signal generator to 365.5 mc using the procedures outlined in steps 4.h.(3), (5), (6), (7), 4.m., 4.n., and 4.o.

(3) Test each tuner by inserting either end of the tuning wand into the access holes on top of the R-F Amplifier Unit. See figure 5-11 for the location of Z-101, Z-102, and Z-103 access holes. Observe the multimeter indication while inserting the tuning wand.

(4) If insertion of the brass end of the tuning wand into any of the r-f tuners increases the multimeter reading, operate the TRACKING CONTROL switch to RUN until the 10-mc dial gear indicator points to M. See figure 5-11 for location of the 10 MC INDICATOR DIAL. Observe that sector number 11 (plain-on rotor plate nearest trimmer), is accessible through the access hole. See figure 5-12 for an illustration of the tuner capacitor sectors. Bend sector number 11 away from the stator plate with the sector bending tool. Return the TRACKING CONTROL switch to NORMAL and observe the multimeter indication while inserting the brass end of the tuning wand. The multimeter indication will decrease if the adjustment was sufficient. If the meter indication still increases, repeat this step until insertion of the brass end of the tuning wand causes the multimeter indication to decrease.

(5) If insertion of the iron end of the tuning wand in any of the r-f tuners causes an increased meter reading on the multimeter, operate the TRACKING CONTROL switch to RUN until the 10-mc dial gear indicator points to M. Bend sector number 11 toward the stator plate with the sector bending tool. Return the TRACKING CONTROL switch to NORMAL and observe the multimeter indication while inserting the iron end of the tuning wand. The multimeter indication will decrease if the adjustment was sufficient. If the meter indication still increases, repeat this step until insertion of the iron end of the tuning wand causes the meter indication to decrease.

(6) Repeat steps 4.q.(1), (2), (3), (4), and (5) at each of the frequencies listed in table XIV. Reference is made to figure 5-12 for location and identification of sectors.

r. Set the receiver POWER ON-OFF switch to OFF and disconnect the cables from the receiver.

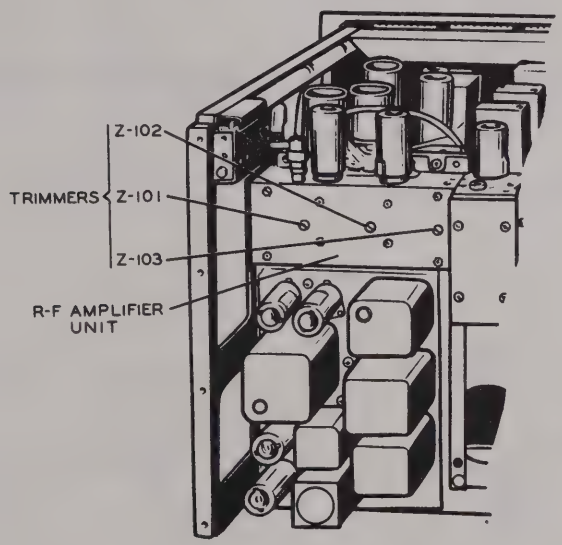


Figure 5-10. **Radio Receiver R-278( )/GR, Partial Rear View, Cover Removed**

s. Disconnect the test equipment and replace the rear frame plate on the receiver.

t. Replace the dust cover and return the receiver to its original condition.

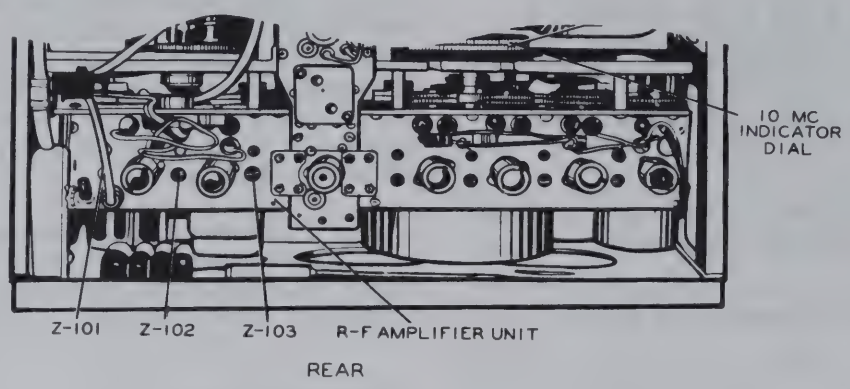


Figure 5-11. **Radio Receiver R-278( )/GR, Partial Top View, Cover Removed**

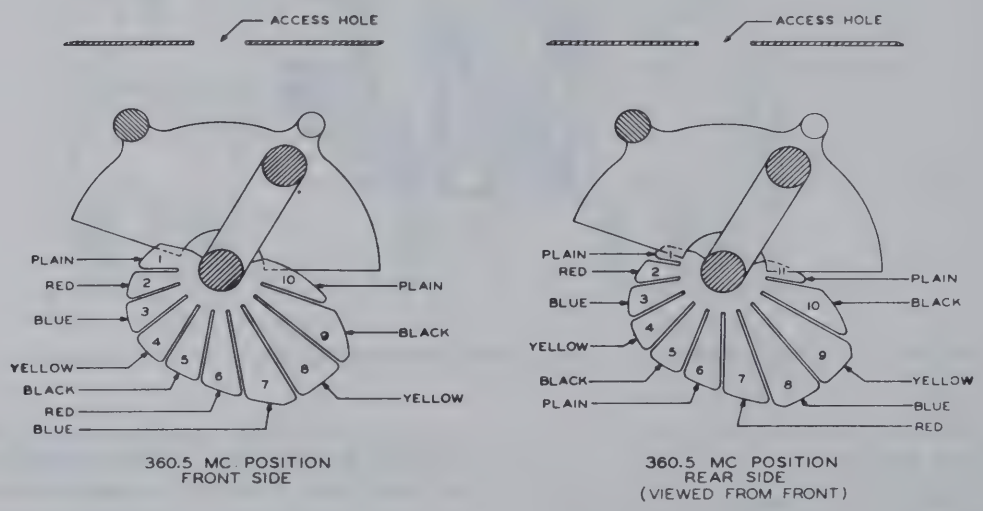


Figure 5-12. **Radio Receiver R-278( )/GR, R-F Amplifier Unit, Tuner Capacitor Sectors**

TABLE XIV. R-F AMPLIFIER ALIGNMENT POINTS

CHANNEL SWITCH SETTINGS	INDICATOR DIAL POSITION	SECTOR	
		NUMBER	COLOR
375.5 mc	L	10 - Front	Plain
385.5 mc	K	10 - Back	Black
395.5 mc	J	9 - Front	Black
355.5 mc	28	1 - Front	Plain
345.5 mc	27	2 - Back	Red
335.5 mc	26	2 - Front	Red
325.5 mc	25	3 - Back	Blue
315.5 mc	24	3 - Front	Blue
305.5 mc	23	4 - Back	Yellow
295.5 mc	22	4 - Front	Yellow
285.5 mc	A	5 - Back	Black
275.5 mc	B	5 - Front	Black
265.5 mc	C	6 - Back	Plain
255.5 mc	D	6 - Front	Red
245.5 mc	E	7 - Back	Red
235.5 mc	F	7 - Front	Blue
225.5 mc	G	8 - Back	Blue

SECTION VI
FIELD MAINTENANCE

6-1. GENERAL.

6-2. This section provides minimum performance standards and troubleshooting data on a subassembly level for Radio Receivers R-278/GR, R-278A/GR, and R-278B/GR. The tabulated information in this section is to be used as the second step in the localization of the cause of equipment failure. (The first step, which is tabulated in Section V, isolated the breakdown to a specific subassembly or circuit.) After locating the faulty component, the subassembly may be placed on a maintenance table and repaired. The minimum performance and troubleshooting tables are used to best advantage in conjunction with the equipment schematics in Section VII.

6-3. DETAILED MINIMUM PERFORMANCE STANDARDS.

6-4. The detailed minimum performance standards for the receiver are listed in Table XV. If any of the subassemblies fail to meet the operating requirements listed in this table, reference should be made to Table XVI, which deals with detailed trouble analysis. As a final step in isolating a failure, the voltage-resistance information contained in Table XVII may be utilized.

NOTE

The readings listed in Table XV were obtained under factory test conditions and may vary, somewhat, with those obtained in the field.

6-5. DETAILED TROUBLE ANALYSIS.

6-6. Table XVI is a troubleshooting chart for localizing trouble to a specific faulty circuit or component of the equipment. This table is to be used only as a guide, and additional tests such a voltage and resistance measurements and sensory examination (aural, visual, smell) may be necessary to isolate a specific faulty component.

6—7. When utilizing the detailed trouble analysis table, it is assumed that all power input to the subassembly being checked are normal and that all other subassemblies are functioning properly. This fact may be determined by following the procedures in the system trouble analysis tables.

6-8. The most frequent cause of trouble in equipment of this type is tube failure. Low emission tubes may be cause of erratic performance of the equipment, while noisy tubes can cause excessive distortion and hum. Before replacing any vacuum tubes, refer to Electron Tube Replacement Policy, T.O. 00-25-149. Defective tubes which cause an overload in power circuits may usually be located by inspection of the various fuses.

NOTE

Do not replace a blown fuse until the circuit in question has been carefully examined to make certain no permanent fault exists.

6-9. REMOVAL.

6-10. **Refer to Section V for removal of the subassemblies in the receiver. The subassemblies are fastened to the main chassis of the receiver by means of captive screws whose heads are painted red to aid in identification.**

6-11. DETAILED ALIGNMENTS AND ADJUSTMENTS.

6-12. Alignments and adjustments relating to specific subassemblies are discussed under Detailed System Alignment in Section V.

6-13. DETAILED LUBRICATION PROCEDURES.

6-14. All moving parts and those subject to friction should be inspected at least once every six months for possible required lubrication. The type of lubricant and the method of application should be that which is described in Section V. A complete lubrication involving the individual subassemblies should be performed at the depot level.

6-15. DETAILED INSPECTION SCHEDULE.

6-16. An inspection of those areas listed in Table XI of Section V should be performed at the prescribed intervals. An electrical check of the equipment, to determine if it meets the deatiled minimum performance standards, should also be performed periodically. Those areas which show wide variations from previous readings, although they may fall within the minimum standards, should be considered as possible sources of failure and the proper action should be taken.

6-17. BENCH TEST SET-UP.

6-18. To gain access to the various subassemblies, the receiver must be removed from the rack and placed on a suitable test bench. Once on the test bench, the test equipment should be connected for the various

checks and alignments as described in the trouble-shooting tables and alignment procedures.

6-19. VOLTAGE-RESISTANCE READINGS.

6-20. The voltage and resistance readings in Table XVII are to be used as an aid in isolating a faulty component. These readings were made on an R-278B/GR receiver and may vary somewhat with readings on the R-278/GR and R-278A/GR receivers in those areas where circuit design is slightly different. Readings may also vary among similar receivers due to differences in tube types and the aging of tubes and components.

TABLE XV. DETAILED MINIMUM PERFORMANCE STANDARDS

STEP	TEST POINT	TEST EQUIPMENT	OPERATING CONDITIONS	NORMAL INDICATION	PROCEDURE FOR ABNORMAL INDICATION
			POWER SUPPLY (FILTER AND RECTIFIER)		
1.	Ⓕ (J1002)	VTVM	Energize the receiver and bypass interlock switch S1206.	+230 ± 15 volts dc. Ripple-voltage = not more than 4.5 volts ac.	See Table XVI, steps 1 and 2.
2.	Ⓗ (J1003)	VTVM	Same as step 1.	-37 to -52 volts dc. Ripple voltage not more than 1.0 volt ac.	See Table XVI, steps 3 and 4.
3.	Ⓖ (J1004)	VTVM	Same as step 1.	+ 210 ± 10 volts dc. Ripple voltage = not more than 0.45 volt ac.	See Table XVI, steps 5 and 6.
			AUDIO AMPLIFIER		
4.	⑩ (J1213)	Audio oscillator, VTVM, 600-ohm, 5-watt resistor.	a. Connect the audio oscillator to Ⓓ (J605) and set for an output of 0.42 volt at 1000 cps; connect the 600-ohm, 5-watt resistor across the VTVM terminals; connect the VTVM to ⑩ (J1213); set the front panel controls as follows: QUIETING control R1204 in full CW position; TRACKING CONTROL switch S1207 in NORMAL position SQUELCH switch S1205 in ON position.	a. 30 to 34 volts ac.	a. See Table XVI, step 7.
			b. Same as above except with TRACKING CONTROL switch S1207 in OFF position.	b. No audio output.	b. See Table XVI, step 8.

TABLE XV. DETAILED MINIMUM PERFORMANCE STANDARDS (cont)

STEP	TEST POINT	TEST EQUIPMENT	OPERATING CONDITIONS	NORMAL INDICATION	PROCEDURE FOR ABNORMAL INDICATION
			THIRD I-F AMPLIFIER		
5.	(A7) (J604)	VTVM, signal generator	a. Remove tube V501 (on second i-f amplifier); connect the VTVM to (A7) (J604); connect the signal generator to (A4) (J503 on second i-f amplifier) and adjust for a reading of -2.0 volts dc on the VTVM at a frequency of 2.05 mc; note the signal generator output and double it; tune the signal generator both above and below the center frequency of 2.05 mc and note the frequency settings required to produce readings of -2.0 volts dc on the VTVM; record the difference of these two settings. To determine the center frequency of this bandwidth, add the two frequency settings on either side of 2.05 mc at which -2.0 volts dc was obtained and then divide by 2. b. Repeat the above procedure with the signal generator output increased to 1000 times that of the initial reference voltage.	a. For receiver R-278/GR, the frequency difference (bandwidth) should not be less than 85 kc. For receivers R-278A/GR and R-278B/GR, the frequency difference should not be less than 65 kc. The bandwidth center frequency should be 2.05 mc 4.0 kc. b. For receiver R-278/GR, the bandwidth should be less than 225 kc. For receivers R-278A/GR and R-278B/GR, the bandwidth should be less than 185 kc.	See Table XVI, step 9.
6.	(8) (J606)	VTVM, signal generator.	Set the front panel controls as follows: MAIN RF GAIN control R1207 (RF GAIN on R-278B/GR) to maximum CW position; AVC switch S1202 (RF GAIN on R-278B/GR) to ON; AVC TIME CONSTANT switch S1204 to COMM and SQUELCH switch S1205 to OFF. Remove tube V501 (on second i-f amplifier); connect the VTVM to (8) signal generator to (A4) (J503 on second i-f amplifier) and adjust for a reading of -3.0	The signal generator output level required to produce -3.0 volts on the VTVM should be not more than 2500 microvolts.	See Table XVI, step 10.

TABLE XV. DETAILED MINIMUM PERFORMANCE STANDARDS (cont)

STEP	TEST POINT	TEST EQUIPMENT	OPERATING CONDITIONS	NORMAL INDICATION	PROCEDURE FOR ABNORMAL INDICATION
			THIRD I-F AMPLIFIER (cont)		
			volts dc on the VTVM at a frequency of 2.05 mc, unmodulated.		
7.	MAIN CARRIER indicator I1203	Visual, signal generator	a. Set MAIN RF GAIN control R1207 (RF GAIN on R-278B/GR) to maximum CW position; remove tube V501 (on second i-f amplifier); connect signal generator to (A4) (J503 on second i-f amplifier) at 2.05 mc, unmodulated; increase output of signal generator until MAIN CARRIER indicator I1203 lights. b. Set MAIN RF GAIN control R1207 (RF GAIN on R-278B/GR) to maximum CCW position and repeat the above procedure.	a. Signal generator output not more than 500 microvolts. b. Signal generator output not less than 10 times the voltage required with MAIN RF GAIN control R1207 in the maximum CW position.	See Table XVI, steps 11 and 12. NOTE MAIN CARRIER indicator I1203 should also light when SQUELCH switch S1205 is placed in the OFF position.
8.	(D) (J605)	Output meter, signal generator.	Remove tube V501 (on second i-f amplifier); connect the output meter to (D) (J605); connect the signal generator to (A4) (J503 on the second i-f amplifier) and adjust for an output of 2.05 mc, modulated 30 percent with a 1000-cps signal, at a level of 4000 microvolts. Note the reading on the output meter. Then reduce the modulation to zero and record the output meter reading decrease in db.	The decrease should not be less than 30 db.	See Table XVI, step 13.
			SECOND I-F AMPLIFIER		
9.	(7) (J504)	VTVM	Connect the VTVM to (7) (J504); operate the 0.1-mc positioner (on the receiver	-10 ± 5 volts dc at all frequencies	See Table XVI, steps 14 and 15.

TABLE XV. DETAILED MINIMUM PERFORMANCE STANDARDS (cont)

STEP	TEST POINT	TEST EQUIPMENT	OPERATING CONDITIONS	NORMAL INDICATION	PROCEDURE FOR ABNORMAL INDICATION
			SECOND I-F AMPLIFIER (cont)		
			front panel) to each position, successively.		
10.	⑧ (J606 on third i-f amplifier)	VTVM, signal generator	Remove V402 (on first i-f amplifier; connect the VTVM to ⑧ (J606); connect the signal generator to (A3) (J404 on first i-f amplifier) and adjust for an output of 162 microvolts at a frequency of 9.5 mc, unmodulated.	-4.0 to -5.5 volts dc.	See Table XVI, step 16.
			FIRST I-F AMPLIFIER		
11.	⑥ (J405)	VTVM	Connect the VTVM to ⑥ (J405); operate the 1.0-mc positioner (on the receiver front panel) to each position, successively.	Not less than -1.5 volts dc at all frequencies.	See Table XVI, steps 17 and 18.
12.	⑧ (J606 on third i-f amplifier)	VTVM, signal generator	Connect VTVM to ⑧ (J606); connect signal generator to Ⓐ (J402) and adjust for an output of 12 microvolts at a frequency of 45.5 mc, unmodulated.	-4.0 to -5.5 volts dc.	See Table XVI, step 19.
			MAIN OSCILLATOR		
13.	⑤ (Junction of R302 and C302 on frequency multiplier amplifier)	VTVM	Connect the VTVM to ⑤ operate the 10-mc positioner (on the receiver front panel) to each position, successively.	-0.5 to -1.5 volts dc at all frequencies.	See Table XVI, steps 20 and 21.
			FREQUENCY MULTIPLIER-AMPLIFIER		
14.	Ⓐ (J402 on first i-f amplifier)	VTVM	Connect the VTVM to Ⓐ (J402); operate the 10-mc positioner (on the receiver front panel) to each position, successively.	-1.0 to -2.5 volts dc at all frequencies.	See Table XVI, steps 22 and 23.

TABLE XV. DETAILED MINIMUM PERFORMANCE STANDARDS (cont)

STEP	TEST POINT	TEST EQUIPMENT	OPERATING CONDITIONS	NORMAL INDICATION	PROCEDURE FOR ABNORMAL INDICATION
			R-F AMPLIFIER		
15.	⑧ (J606 on third i-f amplifier) ⑪ (J1218 on R-278B/GR)	VTVM, signal generator, 6-db, 50-ohm pad.	Set the front panel controls as follows: MAIN RF GAIN control R1207 (RF GAIN control on receiver R-278B/GR) to maximum CW position' AVC switch S1202 to ON (RF GAIN switch on R-278B/GR to LOCAL); AVC TIME CONSTANT switch S1204 to COMM; AF GAIN control R1205 to maximum CCW position; TRACKING CONTROL switch S1207 to NORMAL. Connect the VTVM to ⑧ (J606) or ⑪ (J1218) on R-278B/GR ; connect the signal generator through the 6-db, 50-ohm pad to ① (ANTENNA jack J1212) and adjust for an output of 6 microvolts at the receiver operating frequency. Note the reading on the VTVM. Reduce the signal generator output to zero and again note the reading on the VTVM.	The VTVM reading should decrease at least 1.2 volts dc.	See Table XVI, steps 24 and 25.
			FREQUENCY SELECTING SYSTEM		
16.	Channel and frequency dials on receiver front panel	Visual	All switches in normal operating positions; CHANNEL SELECTOR switch S1101 rotated from one position to another with frequency selecting system allowed to "set up" at each channel position.	Channel and frequency indicated on dials at each position of the CHANNEL SELECTOR switch correspond to the frequencies set up on the frequency preset panel.	See Table XVI, steps 26 through 34.

TABLE XVI. DETAILED TROUBLE ANALYSIS

SYMPTOM	PROBABLE CAUSE	REMEDY
	POWER SUPPLY (FILTER AND RECTIFIER)	
1. No voltage reading at Ⓕ (J1002).	a. Time-delay relay K901 defective	a. Check and replace K901.

TABLE XVI. DETAILED TROUBLE ANALYSIS (cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
POWER SUPPLY (FILTER AND RECTIFIER) (cont)		
	b. Transformer T901 or T902 defective.	b. Check and replace T901 and T902.
	c. Rectifier V901 defective.	c. Check and replace V901.
2. Excessive ripple voltage at Ⓕ (J1002); d-c reading normal.	Inductance L1001 or capacitor C1001 defective.	Check and replace L1001 and C1001.
3. No voltage or incorrect voltage reading at Ⓗ (J1003); normal reading at Ⓕ (J1003).	Rectifier V902 or V903 defective.	Check and replace V902 and V903.
4. Excessive ripple voltage at (J1003); d-c reading normal.	Capacitor C1006 or C1007 defective.	Check and replace C1006 and C1007.
5. No voltage reading at Ⓖ (J1004).	See step 1.	See step 1.
6. Excessive ripple voltage at Ⓖ (J1004); d-c reading normal	Inductance L1002 or capacitor C1002 defective	Check and replace L1002 and C1002.
AUDIO AMPLIFIER		
7. No audio output or insufficient audio output at ⑩ (J1213).	a. Tube V606B (in third i-f amplifier), V801, V802, or V803 defective.	a. Check and replace V606, V801, V802 and V803.
	b. Transformer T801 or T802 defective.	b. Check and replace T801 and T802.
8. Audio output normal with TRACKING CONTROL switch S1207 in the OFF position.	Muting relay K802 defective.	Check and replace K802.
THIRD I-F AMPLIFIER		
9. Abnormal bandwidth characteristics observed at (A_7) (J604).	Transformer T601, T602, T603 or T604 misaligned.	Align T601, T602, T603 and T604. (See paragraphs 5-26 and 5-27.)
10. Insufficient gain measured at ⑧ (J606); normal bandwidth characteristics observed at (J604).	Tube V601, V602, V603, V604, or V607 defective.	Check and replace V601, V602, V603, V604 and V607.
11. MAIN CARRIER indicator I1203 does not light when SQUELCH switch S1205 is placed in the OFF position.	Carrier-operated relay K801 defective.	Check and replace K801.
12. Excessive signal required to illuminate MAIN CARRIER indicator I1203; gain of third i-f amplifier normal; I1203 lights normally with SQUELCH switch S1205 in the OFF position.	Tube V608 or V609 defective.	Check and replace V608 and V609.

TABLE XVI. DETAILED TROUBLE ANALYSIS (cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
THIRD I-F AMPLIFIER (cont)		
13. Insufficient decrease in db output observed at (D) (J605) with modulated and then unmodulated signal applied to (A4) (J503 on second i-f amplifier); gain of third i-f amplifier measured at (8) (J606) normal.	Tube V605 or V608B defective.	Check and replace V605 and V608.
SECOND I-F AMPLIFIER		
14. Incorrect voltage indicator at (7) (J504) for all frequencies.	Tube V502B defective.	Check and replace V502.
15. Incorrect voltage indicator at (7) (J504) at one frequency.	Crystal (Y501 through Y510) corresponding to frequency at which incorrect reading is obtained is defective.	Check and replace crystal.
16. Incorrect voltage indication at (8) (J606 on third i-f amplifier) with signal input at (A3) (J404 on first i-f amplifier); normal readings at (7) (J504).	a. Tube V501 or V502A defective. b. Transformer T501 or T502 misaligned.	a. Check and replace V501 and V502. b. Align T501 and T502. (See paragraphs 5-29 and 5-30.)
FIRST I-F AMPLIFIER		
17. Incorrect voltage indication at (6) (J405) for all frequencies.	a. Tube V404 defective. b. Transformer T403 misaligned.	a. Check and replace V404. b. Align T403. (See paragraph 5-32.)
18. Incorrect voltage indication at (6) (J405) for one frequency.	Crystal (Y401 through Y410) corresponding to frequency at which incorrect reading is obtained is defective.	Check and replace crystal.
19. Incorrect voltage indication at (8) (J606 on third i-f amplifier) with signal input at (A) (J402); normal readings at (6) (J405).	a. Tube V401, V402, or V403 defective. b. Transformer T401 or T402 misaligned.	a. Check and replace V401, V402, and V403. b. Align T401 and T402. (See paragraph 5-32.)
MAIN OSCILLATOR		
20. Incorrect voltage indication at (5) (junction of R302 and C302 on frequency multiplier-amplifier) at all frequencies.	a. Tube V201 defective. b. Improper placement of capacitor C301 (on frequency multiplier-amplifier).	a. Check and replace V201. b. Arrange C301 for maximum voltage indication on vtvm.

TABLE XVI. DETAILED TROUBLE ANALYSIS (cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
	MAIN OSCILLATOR (cont)	
21. Incorrect voltage indication at (5) (junction of R302 and C302) at one frequency.	a. Coil (L222 through L239) corresponding to frequency at which incorrect reading is obtained is not tuned properly.	a. Tune coil. (See paragraph 5-35 or 5-36.)
	b. Crystal (Y201 through Y218) corresponding to frequency at which incorrect reading is obtained is defective.	b. Check and replace crystal. NOTE Replacement of a crystal or coil requires retuning of the oscillator at that frequency.
	FREQUENCY MULTIPLIER-AMPLIFIER	
22. Incorrect voltage reading at (A_1) (junction of R307 and C309).	a. Tube V301 defective.	a. Check and replace V301.
	b. Tuner Z301 misaligned.	b. Align Z301. (See paragraphs 5-38 and 5-39.)
23. Incorrect voltage reading at (A) (J402 on first i-f amplifier); normal reading at (A_1) (junction of R307 and C309).	a. Tube V302, V303, V304 or V305 defective.	a. Check and replace V302, V303, V304, and V305.
	b. Tuner Z303, Z305, Z307 or Z309 misaligned.	b. Align Z303, Z305, Z307, and Z309. (See paragraphs 5-38 and 5-39.) NOTE Replacement of tubes requires the realignment of their corresponding tuners.
	R-F AMPLIFIER	
24. Insufficient difference in voltage readings at (8) (J606 of third i-f amplifier) at all frequencies with conditions as set up in Table XV, step 15.	a. Tube V101 or V102 defective.	a. Check and replace V101 and V102.
	b. Trimmer capacitor of tuner Z101, Z102, or Z103 not set properly.	b. Adjust trimmers of Z101, Z102 and Z103. (See paragraphs 5-42 and 5-43.)
25. Insufficient difference in voltage readings at (8) (J606) at one frequency with conditions as set up in Table XV, step 15.	Tuner Z101, Z102 or Z103 not tracked properly.	Track Z101, Z102 and Z103. (See paragraphs 5-42 through 5-44.)
	FREQUENCY SELECTING SYSTEM	
26. Frequency selecting system inoperative (indicators on receiver front panel do not change position when CHANNEL SELEC-	a. Relay K1201, K1202 or K1101 defective.	a. Check and replace K1201, K1202 and K1101.
	b. Motor B1101 defective.	b. Check and replace B1101.

TABLE XVI. DETAILED TROUBLE ANALYSIS (cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
FREQUENCY SELECTING SYSTEM (Cont)		
TOR switch S1101 is rotated); normal signal obtained at present frequency.	c. Slip clutch of channel autopositioner defective. d. Mechanical linkage between motor B1101 and switch S1102(and channel indicator dial) defective.	c. Check and replace slip clutch of channel autopositioner. d. Check and correct mechanical linkage. NOTE If removal and replacement of components is not obvious, the unit should be returned to depot.
27. Indicators position correctly with the exception of the 10-mc indicator; motor B1101 continues to operate.	a. 10-mc autopositioner slip clutch defective. b. Insufficient tension on 10-mc autopositioner pawl spring (preventing pawl from dropping into proper stop-wheel notch).	a. Check and replace 10-mc autopositioner slip clutch. b. Replace spring. NOTE If new spring is not available, bend old spring to increase tension.
28. Indicators position correctly with the exception of 10-mc indicator, which remains stationary; motor B1101 stops at completion of cycle.	Relay K1102 defective.	Check and replace K1102.
29. Indicators position correctly with the exception of 1.0-mc indicator; motor B1101 continues to operate.	a. 1.0-mc autopositioner slip clutch defective. b. Insufficient tension on 1.0-mc autopositioner pawl spring.	a. Check and replace 1.0-mc autopositioner slip clutch. b. Replace spring. (See NOTE of step 27.)
30. Indicators position correctly with the exception of 1.0-mc indicator, which remains stationary; motor B1101 stops at completion of cycle.	Relay K1103 defective.	Check and replace K1103.
31. Indicators position correctly with the exception of 1.0-mc indicator; motor B1101 continues to operate.	a. 0.1-mc autopositioner slip clutch defective. b. Insufficient tension on 1.0-mc autopositioner pawl spring.	a. Check and replace 1.0-mc autopositioner slip clutch. b. Replace spring. (See NOTE of step 27.)
32. Indicators position correctly with the exception of 0.1-mc indicator; which remains stationary; motor B1101 stops at completion of cycle.	Relay K1104 defective.	Check and replace K1104.

TABLE XVI. DETAILED TROUBLE ANALYSIS (cont)

SYMPTOM	PROBABLE CAUSE	REMEDY
FREQUENCY SELECTING SYSTEM (Cont)		
33. Channel indicator dial continues to hunt after frequency selection is initiated; remaining frequency indicator dials remain stationary.	Insufficient tension on channel autopositioner pawl spring.	Replace spring. (See NOTE of step 27.)
34. Frequency selecting system does not operate in several positions of CHANNEL SELECTOR switch S1101 but operates normally on the remaining positions.	CHANNEL SELECTOR switch S1101 defective.	Check and replace S1101.

TABLE XVII. VOLTAGE-RESISTANCE READINGS

NOTE

Resistance and d-c voltage readings made with vtvm model HP-410B; a-c voltage readings made with a-c meter model Weston 904; line voltage at 115 volts rms.

TUBE	PIN NO.	VOLTS	OHMS (to ground)
R-F AMPLIFIER			
V101	1	-0.75	300K
	2	1.4	100
(6J4WA)	3	6.6 ac	1.0
	4	0	0
	5	-0.75	300K
	6	-0.75	300K
	7	150	Inf.
V102	1	-0.63	300K
(6J4WA)	2	1.2	100
	3	6.6 ac	1.0
	4	0	0
	5	-0.63	300K
	6	-0.63	300K
	7	150	Inf.

TUBE	PIN NO.	VOLTS	OHMS (to ground)
MAIN OSCILLATOR			
V201	1	178	Inf.
(12AT7WA)	2	0	22
	3	1.85	340
	4	6.5 ac	0.5
	5	6.5 ac	0.5
	6	200	Inf.
	7	0	0
	8	2.2	340
	9	0	0
FREQUENCY MULTIPLIER-AMPLIFIER			
V301	1	-5.7	115K
(5654/6AK5W)	2	0	0
	3	0	0
	4	6.5 ac	0.5

TABLE XVII. VOLTAGE-RESISTANCE READINGS (cont)

TUBE	PIN NO.	VOLTS	OHMS (to ground)
FREQUENCY MULTIPLIER-AMPLIFIER (cont)			
V301 (cont)	5	185	Inf.
	6	60	Inf.
	7	0	0
V302	1	-0.92	115K
(5654/6AK5W)	2	0	0
	3	6.5 ac	0.5
	4	0	0
	5	178	Inf.
	6	80	Inf.
	7	0	0
V303	1	0	0
6J4WA	2	0.36	100
	3	0	0
	4	6.5 ac	0.5
	5	0	0
	6	0	0
	7	5.5	Inf.
V304	1	0	0
(6J4WA)	2	0.40	100
	3	0	0
	4	6.5 ac	0.5
	5	0	0
	6	0	0
	7	53	Inf.
V305	1	0	0
(6J4WA)	2	0.42	100
V305 (cont)	3	0	0
	4	6.5 ac	0.5
	5	0	0
	6	0	0
	7	47	Inf.
FIRST I-F AMPLIFIER			
V401	1	-1.0	95K
5654/6AK5W	2	0.35	100
	3	0	0
	4	6.6	1.4
	5	73	360K
	6	48	400K
	7	0.35	100
V402	1	-1.6	Inf.
(5654/6AK5W)	2	0	0
	3	0	0
	4	6.6 ac	1.4
	5	72	400K
	6	59	420K
	7	0	0
V403	1	-1.4	95K
(5654/6AK5W)	2	1.8	7.2K
	3	0	0
	4	6.0	1.3
	5	75	Inf.
	6	26	58K

TABLE XVII. VOLTAGE-RESISTANCE READINGS (cont)

TUBE	PIN NO.	VOLTS	OHMS (to ground)
FIRST I-F AMPLIEIER (cont)			
	7	1.8	7K
V404	1	110	320K
(12AT7WA)	2	0.25	4.5K
	3	0	0
	4	0	0
	5	0	0
	6	78	320K
	7	0	0
	8	0	0
	9	6.2 ac	1.3
SECOND I-F AMPLIFIER			
V501	1	0.35	275K
(6AU6)	2	0	0
	3	0	0
	4	6.5 ac	1.75
	5	208	160K
	6	145	190K
	7	2	32o
V502	1	190	0.7
(5814Λ)	2	-10.5	24K
	3	3.4	240
	4	0	0
	5	0	0
	6	61	85K
	7	1.0	110K
	8	3.4	220
	9	6.3 ac	0.7

TUBE	PIN NO.	VOLTS	OHMS (to ground)
THIRD I-F AMPLIFIER			
V601	1	-2.5	Inf.
(5749.6BA6W)	2	0	0
	3	0	0
	4	6.5 ac	0.4
	5	168	30K
	6	125	37K
	7	0	0
V602	1	-2.5	Inf.
(5749/6BA6W)	2	0	0
	3	6.7 ac	0.4
	4	0	0
	5	163	30K
	6	120	37K
	7	0	0
V603	1	0	0.8
(5749/6BA6W)	2	3.6	470
	3	0	0
	4	6.5	0.4
	5	206	Inf.
	6	100	Inf.
	7	3.6	470
V604	1	-3.5	70K
(5726/6AL5W)	2	-3.5	70K
	3	0	0
	4	6.5	0.4
	5	7.6	11K

TABLE XVII. VOLTAGE-RESISTANCE READINGS (cont)

TUBE	PIN NO.	VOLTS	OHMS
THIRD I-F AMPLIFIER (cont)			
V604 (cont)	6	0	0
	7	-17.2	120K
V605	1	-3.6	70K
(5726/6AL5W)	2	1.3	44K
	3	0	0
	4	6.5	0.4
	5	2.5	1M
	6	0	0
	7	-19	35K
V606	1	125	Inf.
(5814A)	2	22	450K
	3	22.5	2200
	4	6.5 ac	0.4
	5	6.5 ac	0.4
	6	110	
	7	0	150K
	8	4.6	2.2K
	9	0	0
V607	1	-2.9	Inf.
(5814A)	2	-19	600K
	3	-17	190K
	4	6.5 ac	0.4
	5	6.5 ac	0.4
	6	13 ac	100K
	7	-0.05	100K
	8	4.9	300

TUBE	PIN NO.	VOLTS	OHMS (to ground)
THIRD I-F AMPLIFIER (cont)			
	9	0	0
V608	1	220	132K
(12AX7)	2	0	470K
	3	16	15K
	4	6.5 ac	0.4
	5	6.5 ac	0.4
	6	67	460K
	7	-3.5	380K
	8	3.8	350
	9	0	0
V609	1	N.C.	N.C.
(6C4)	2	N.C.	N.C.
	3	0	0
	4	6.5	0.4
	5	160	Inf.
	6	67	460K
	7	69	6K
AUDIO AMPLIFIER			
V801	1	78	Inf.
(5814A)	2	0	100K
	3	1.85	1K
	4	6.5 ac	0.7
	5	6.5 ac	0.7
	6	215	Inf.
	7	0	45K
	8	5.6	470

TABLE XVII. VOLTAGE-RESISTANCE READINGS (cont)

TUBE	PIN NO.	VOLTS	OHMS (to ground)
AUDIO AMPLIFIER (cont)			
	9	0	0
V802	1	-11	115K
(6005/6AQ5W)	2	0	0
	3	0	0
	4	6.5 ac	0.7
	5	225	Inf.
	6	235	Inf.
	7	-11	115K
V803	1	-11	115K
(6005/6AQ5W)	2	0	0
	3	0	0
	4	6.5 ac	0.7
	5	225	Inf.
	6	235	Inf.
	7	-11	115K
V804	1	147	Inf.
(OA2)	2	0	0
	3	10	N.C.
	4	0	0
	5	147	Inf.
	6	4.3	N.C.
	7	0	0
POWER SUPPLY RECTIFIER			
V901	1	252	Inf.
(3B22)	2	215 ac	Inf.
	3	210 ac	Inf.
	4	252	Inf.
V902	1	119	Inf.
(3B22)	2	143 ac	13
	3	148 ac	13
	4	119	Inf.
V903	1	-186	Inf.
(6X4W)	2	N.C.	N.C.
	3	0	0
	4	6.5 ac	0
	5	N.C.	N.C.
	6	-176	Inf.
	7	145 ac	3.8

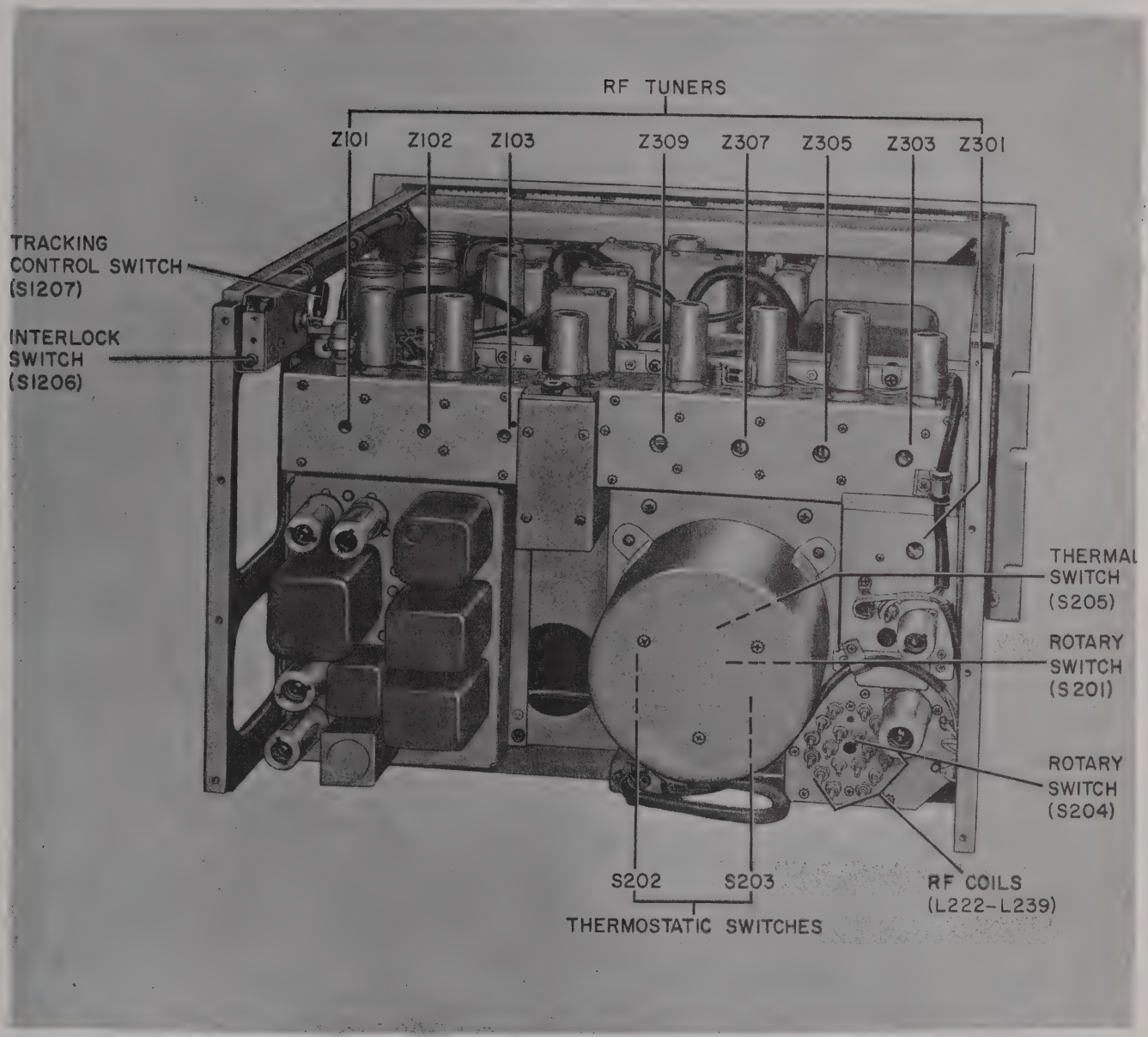


Figure 6-1. Receiver, Rear View, Maintenance Controls

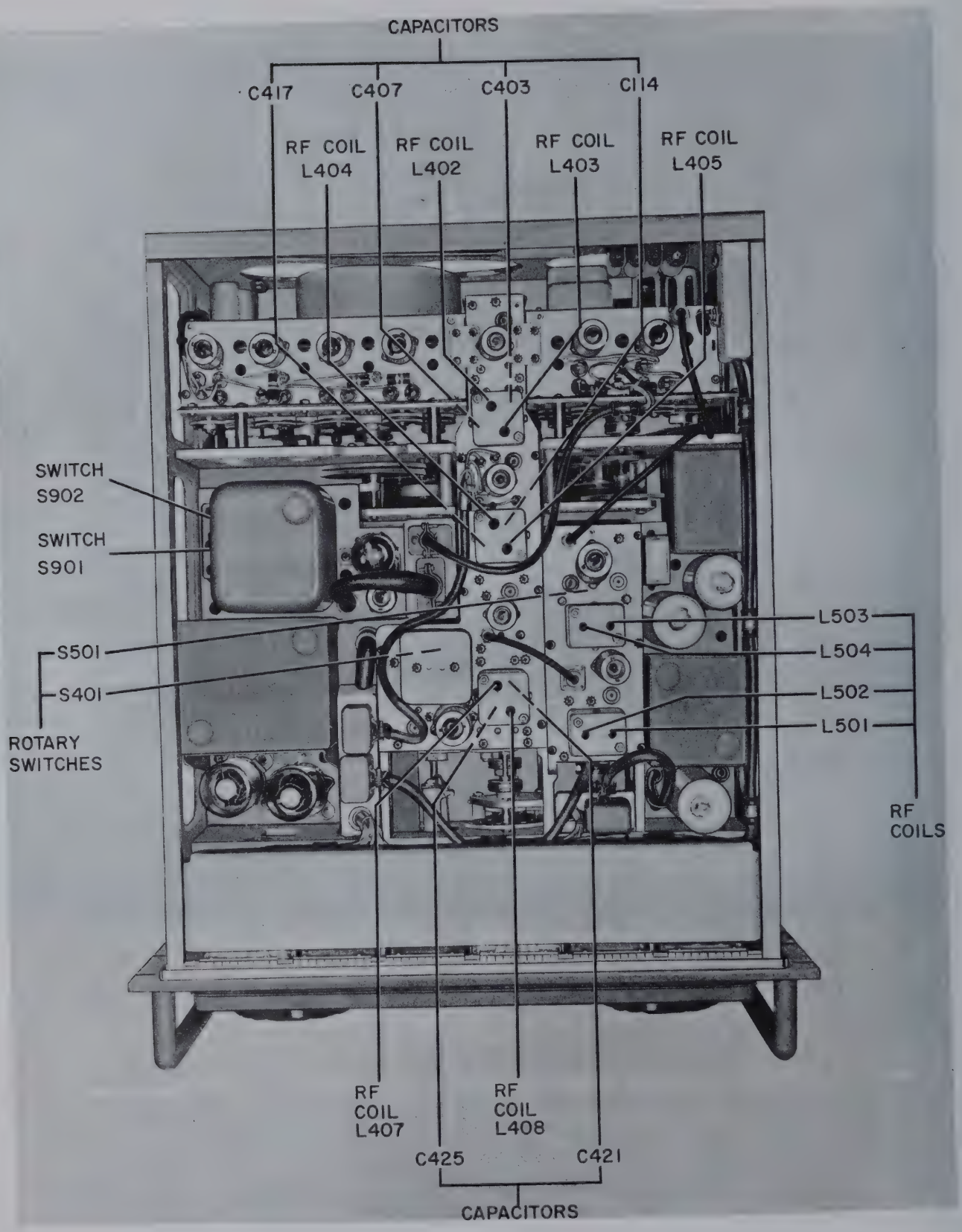


Figure 6-2. Receiver, Top View, Maintenance Controls

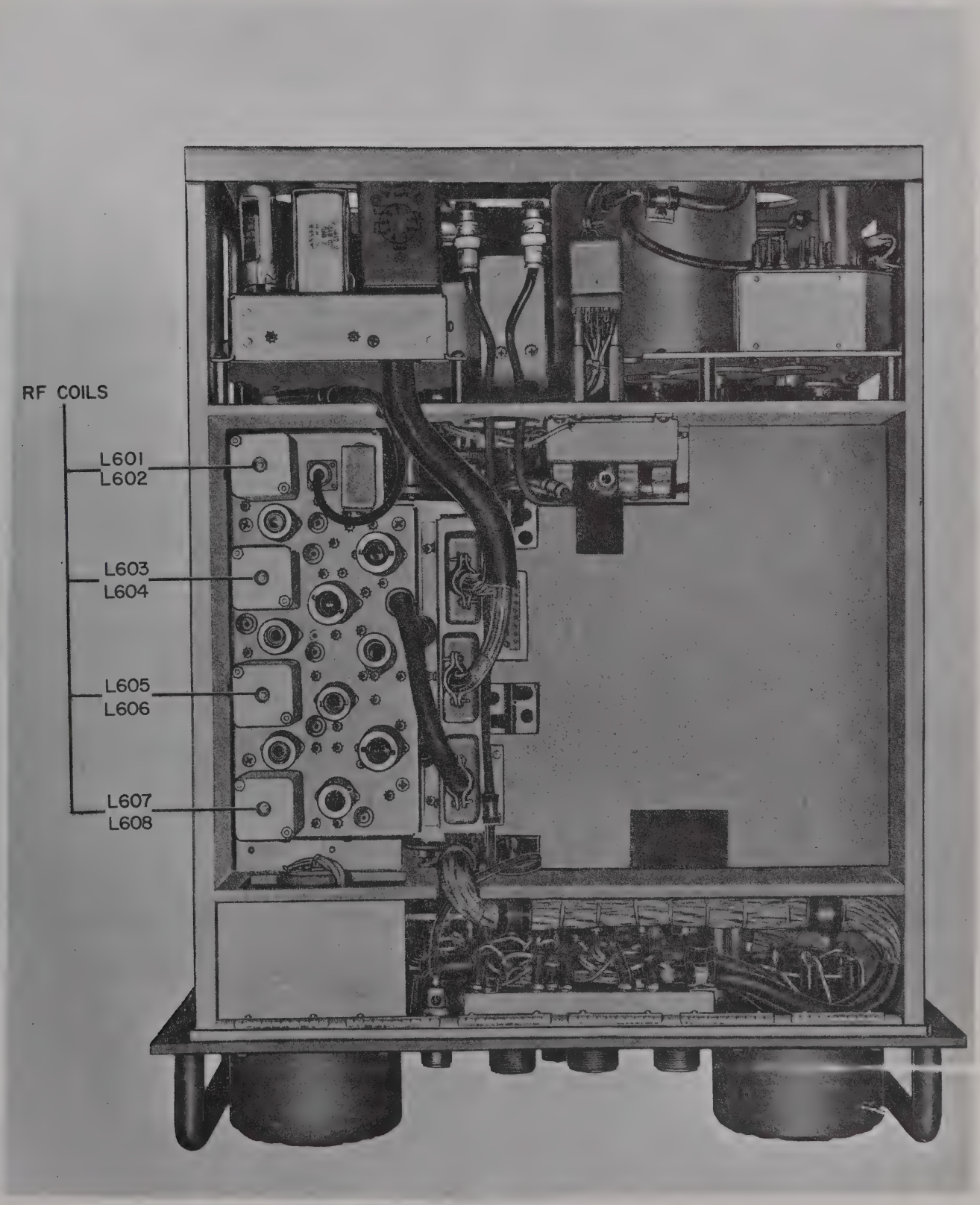


Figure 6-3. Receiver, Bottom View, Maintenance Controls

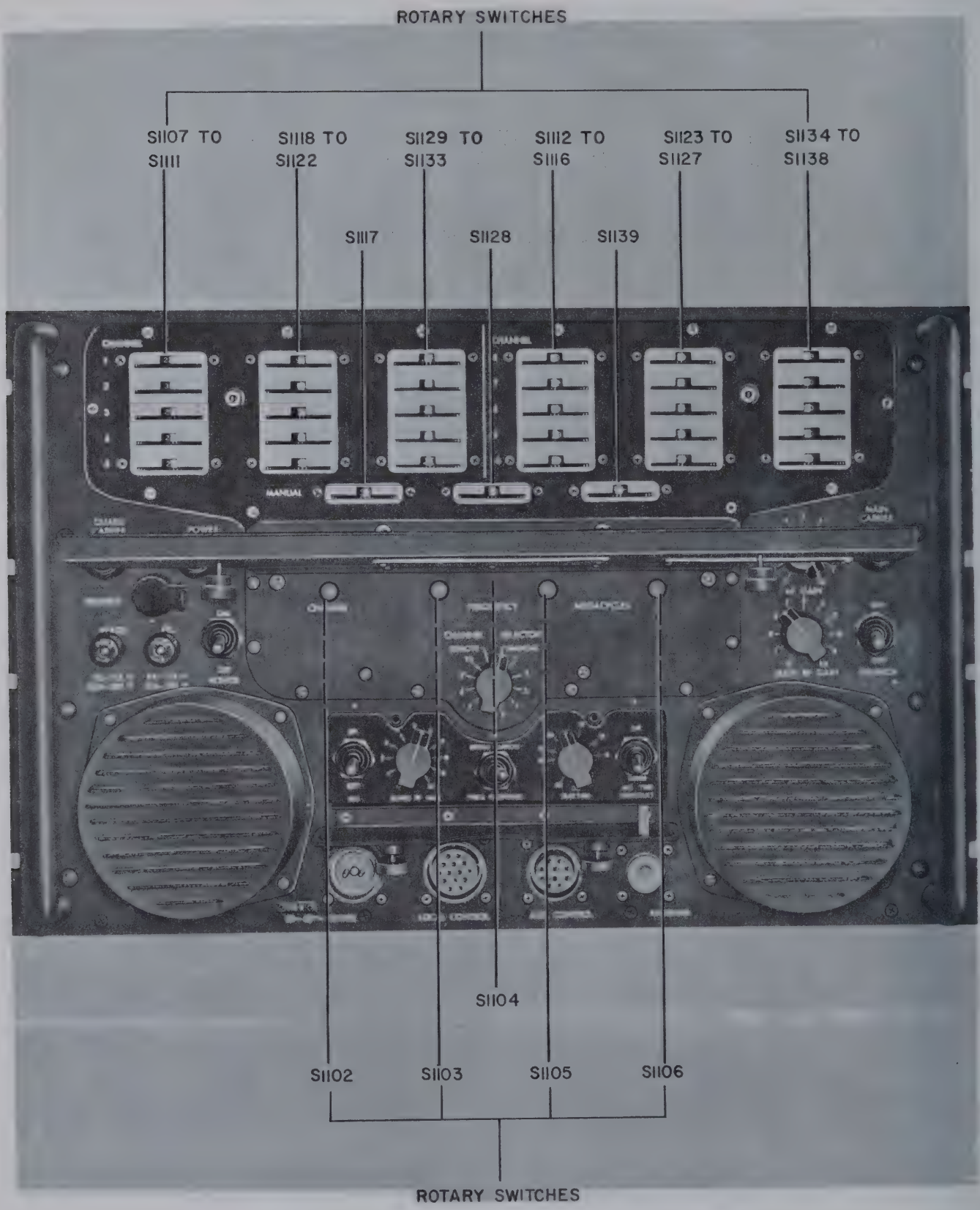
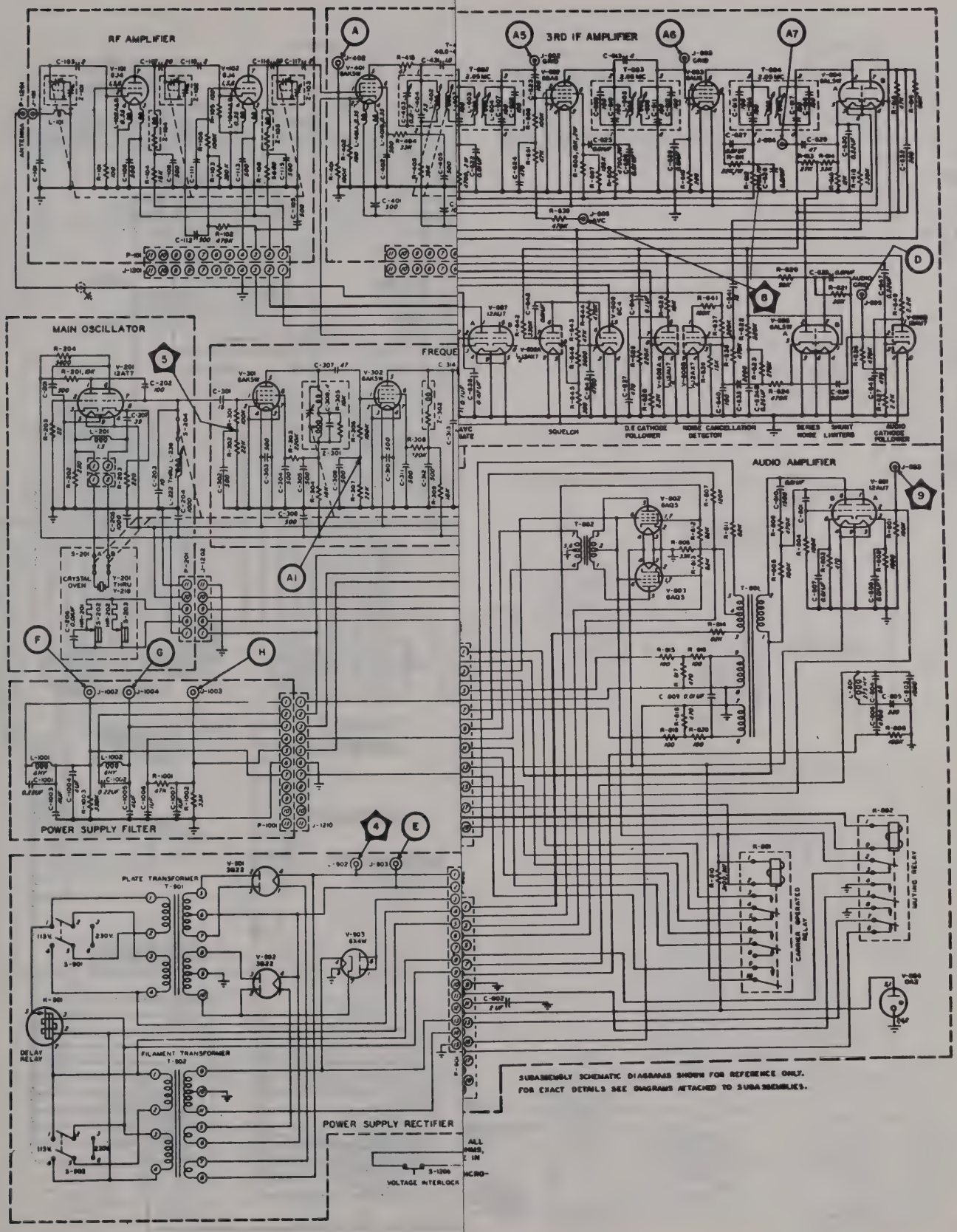


Figure 6-4. Receiver, Front View, Maintenance Controls

SECTION VII
DIAGRAMS

This section contains those schematics which are needed by the maintenance technician to accomplish trouble analysis on inoperative or malfunctioning equipment. They are to be used in conjunction with the system maintenance and detailed maintenance material contained in Sections V and VI. A list of these schematics appears in the front of this manual.



278/GR, Schematic Diagram

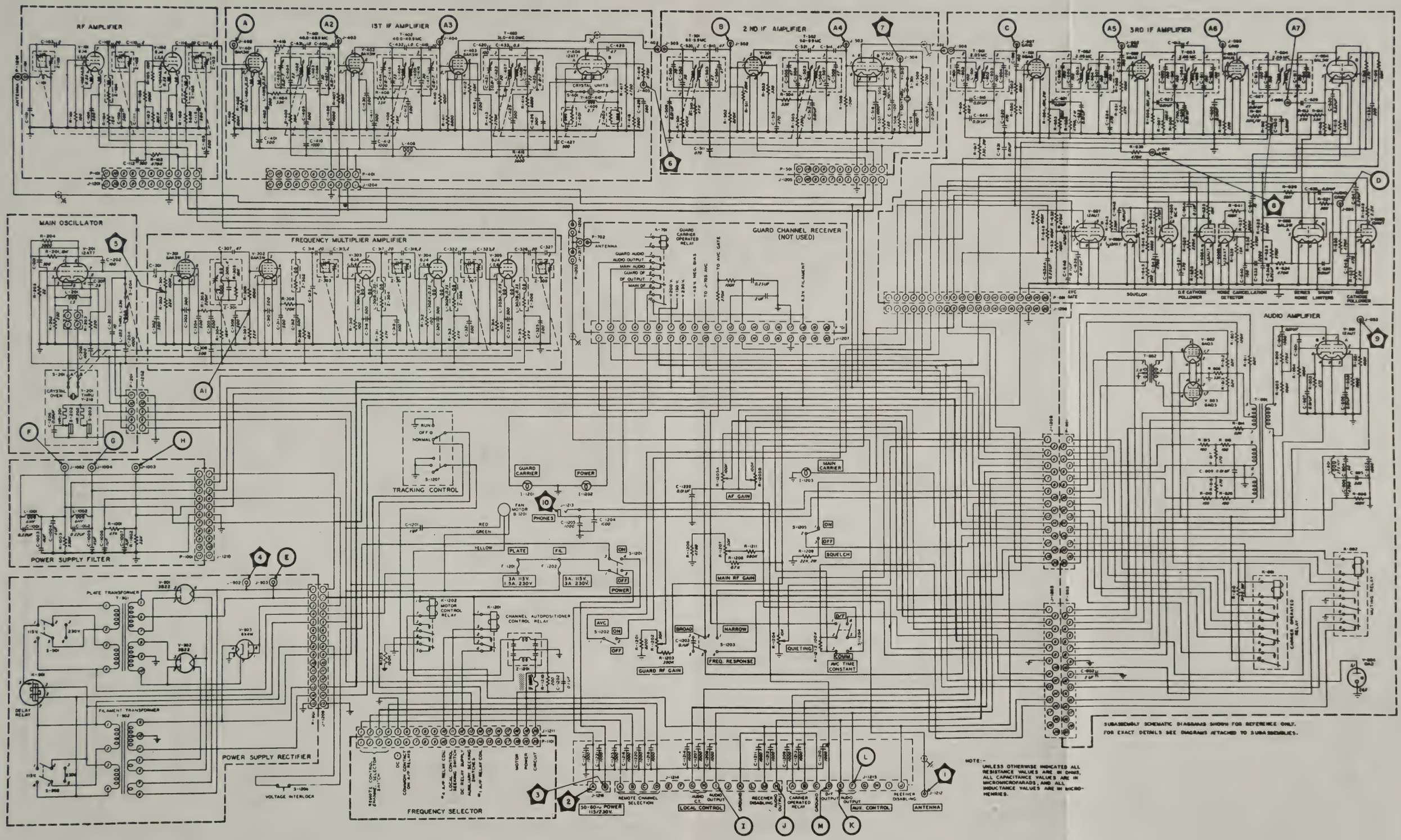


Figure 7-1. Radio Receiver R-278/GR, Schematic Diagram

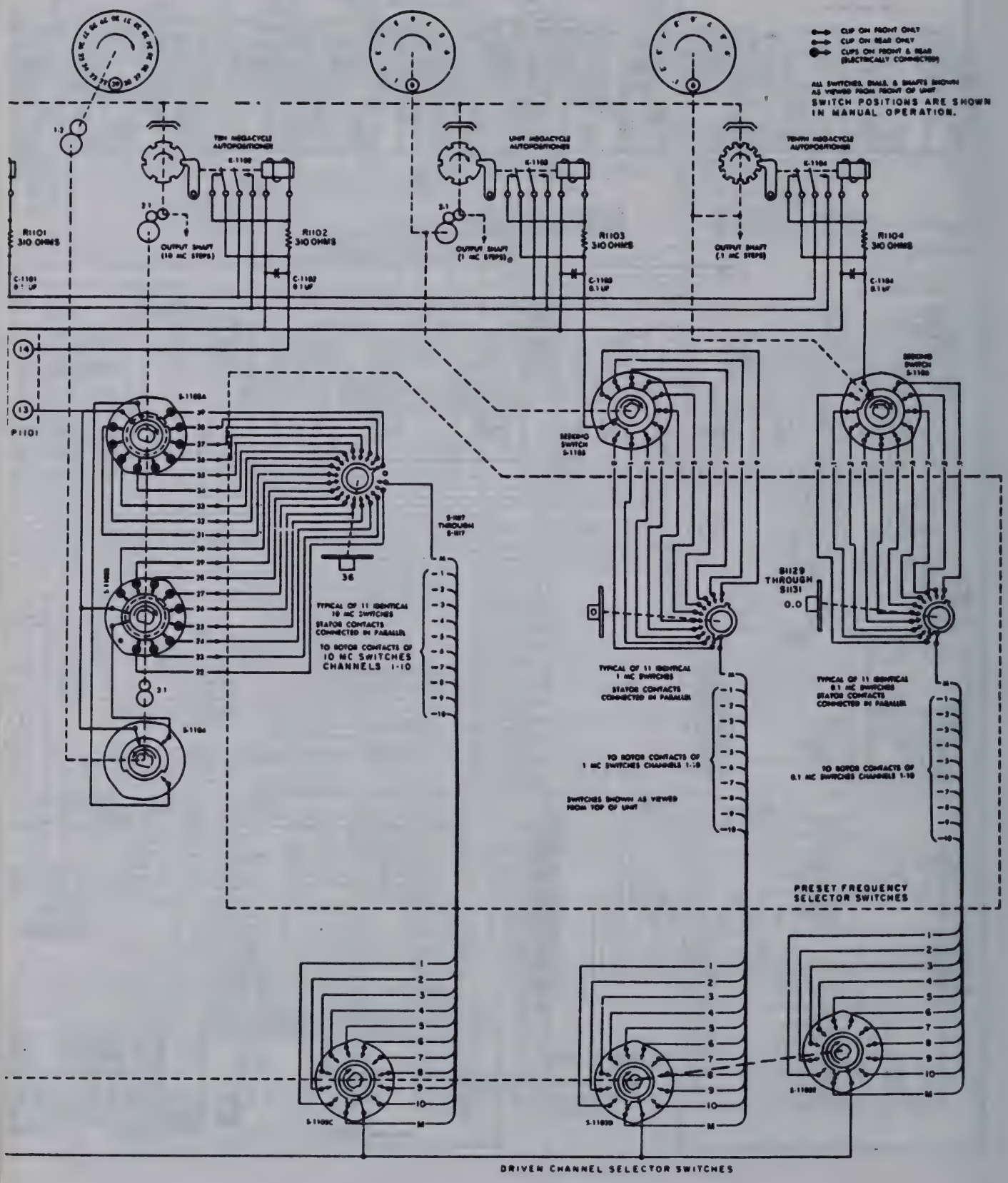
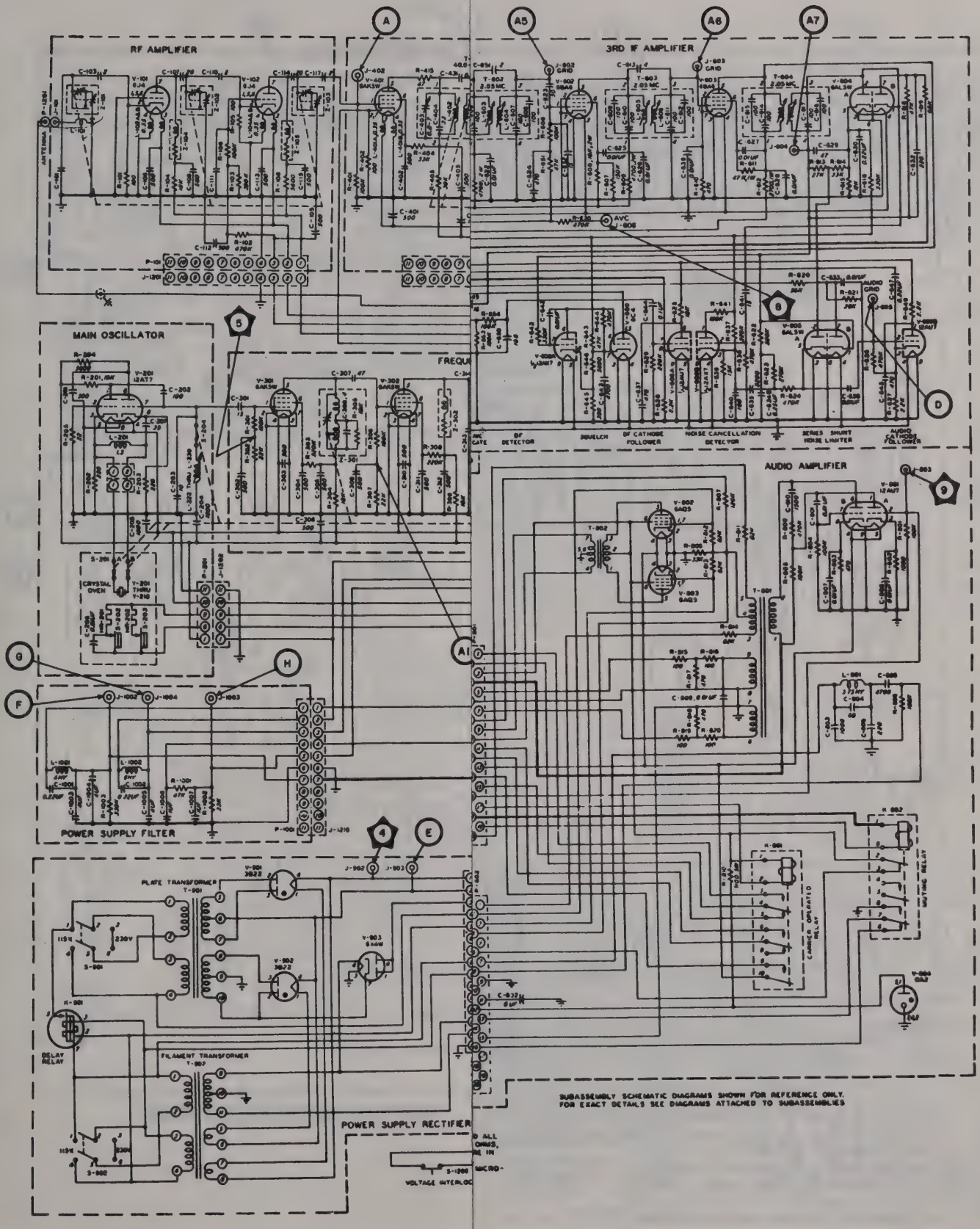


Figure 7-2. Frequency Selector System, Schematic Diagram



-278A/GR, Schematic Diagram

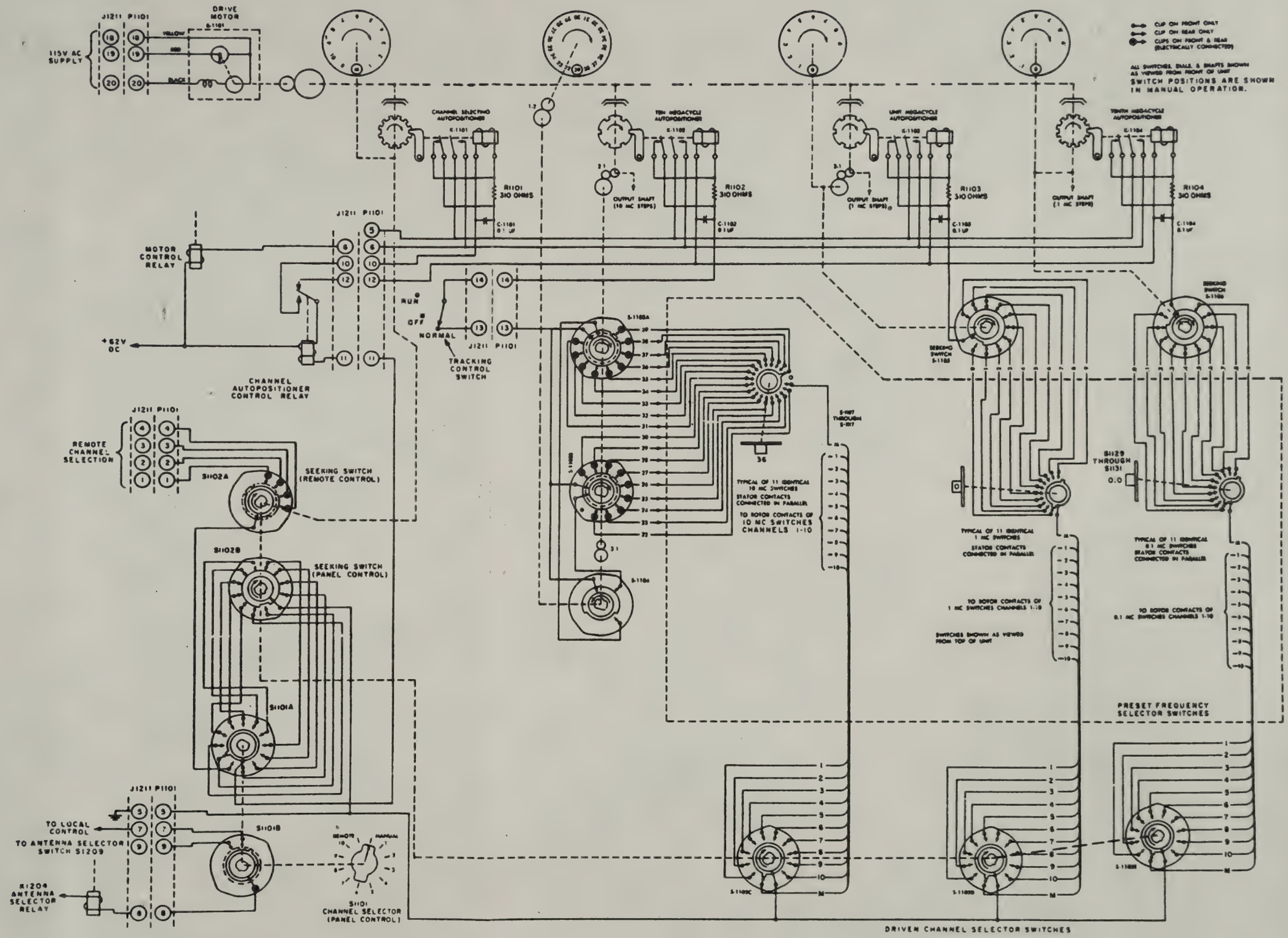


Figure 7-2. Frequency Selector System, Schematic Diagram

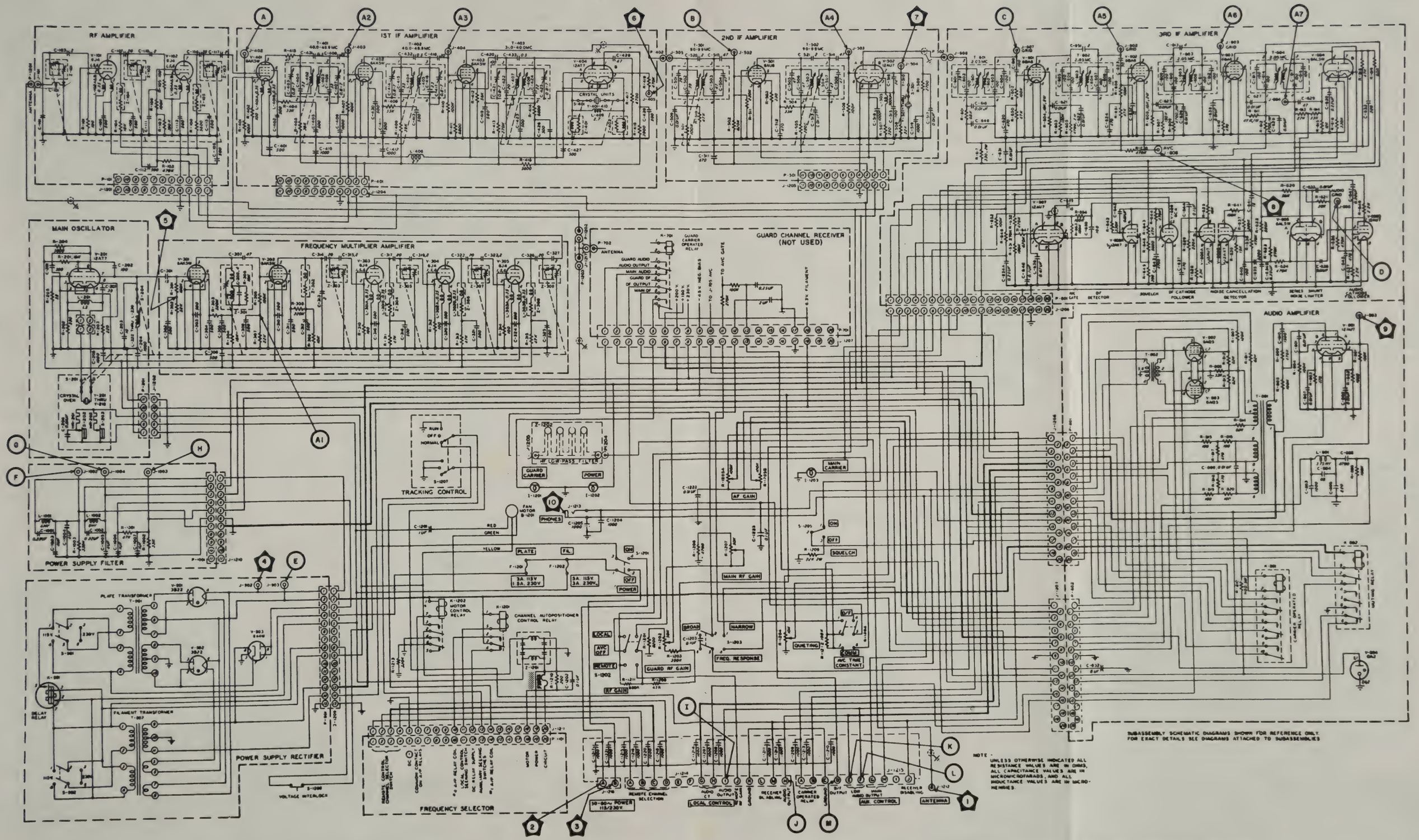

RF AMPLIFIER
1ST IF AMPLIFIER
2ND IF AMPLIFIER
3RD IF AMPLIFIER
MAIN OSCILLATOR
FREQUENCY MULTIPLIER AMPLIFIER
GUARD CHANNEL RECEIVER (NOT USED)
AUDIO AMPLIFIER
POWER SUPPLY FILTER
POWER SUPPLY RECTIFIER
FREQUENCY SELECTOR
TRACKING CONTROL
CHANNEL AUTOPOSITIONER CONTROL RELAY
PLATE TRANSFORMER T-901
FILAMENT TRANSFORMER T-902
CRYSTAL UNITS
SUBASSEMBLY SCHEMATIC DIAGRAMS SHOWN FOR REFERENCE ONLY. FOR EXACT DETAILS SEE DIAGRAMS ATTACHED TO SUBASSEMBLIES
NOTE: UNLESS OTHERWISE INDICATED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES

Figure 7-3. Radio Receiver R-278A/GR, Schematic Diagram

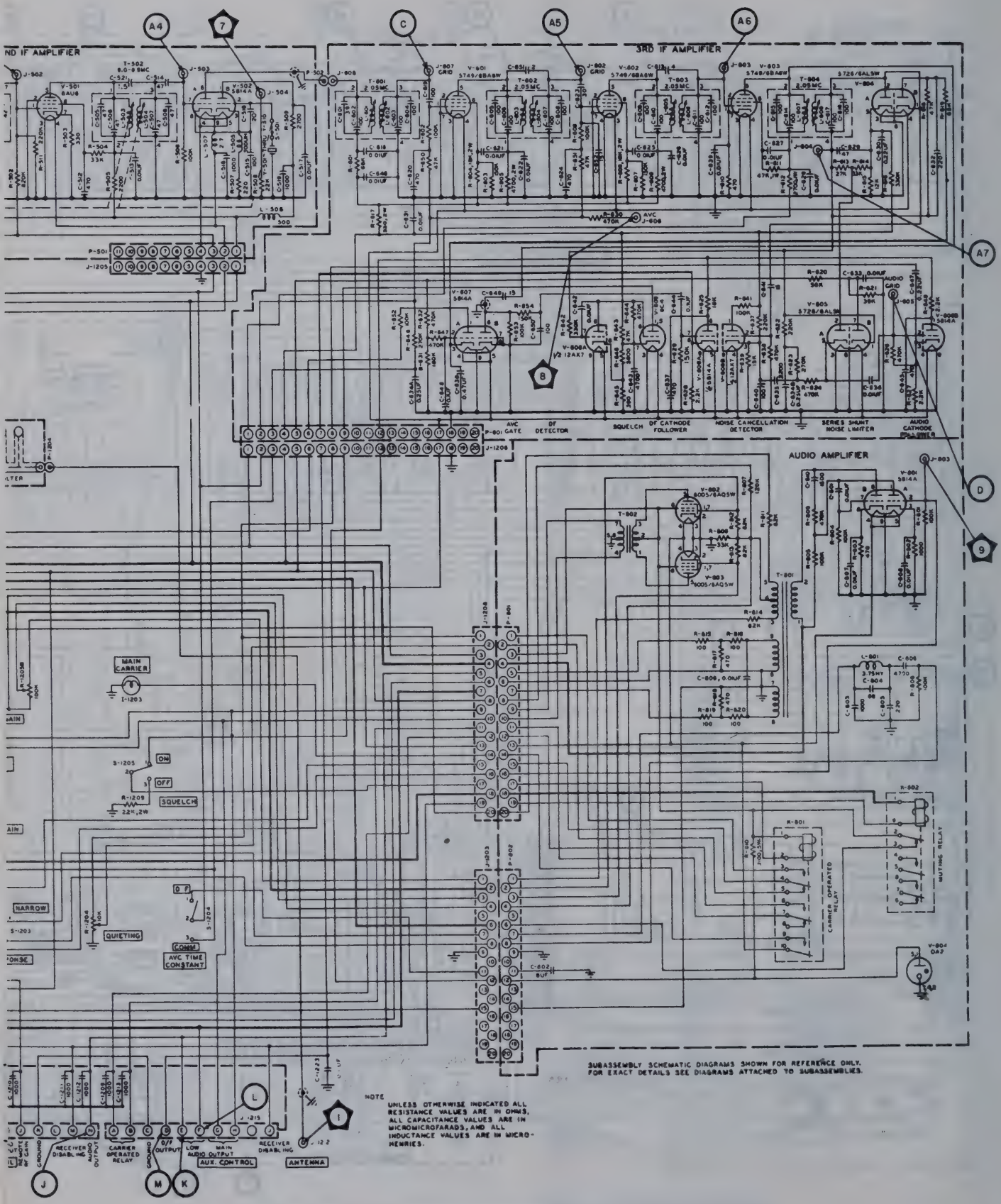


Figure 7-4. Radio Receiver R-278B/GR, Schematic Diagram

SECTION VIII
DIFFERENCE DATA SHEETS

(Not applicable)

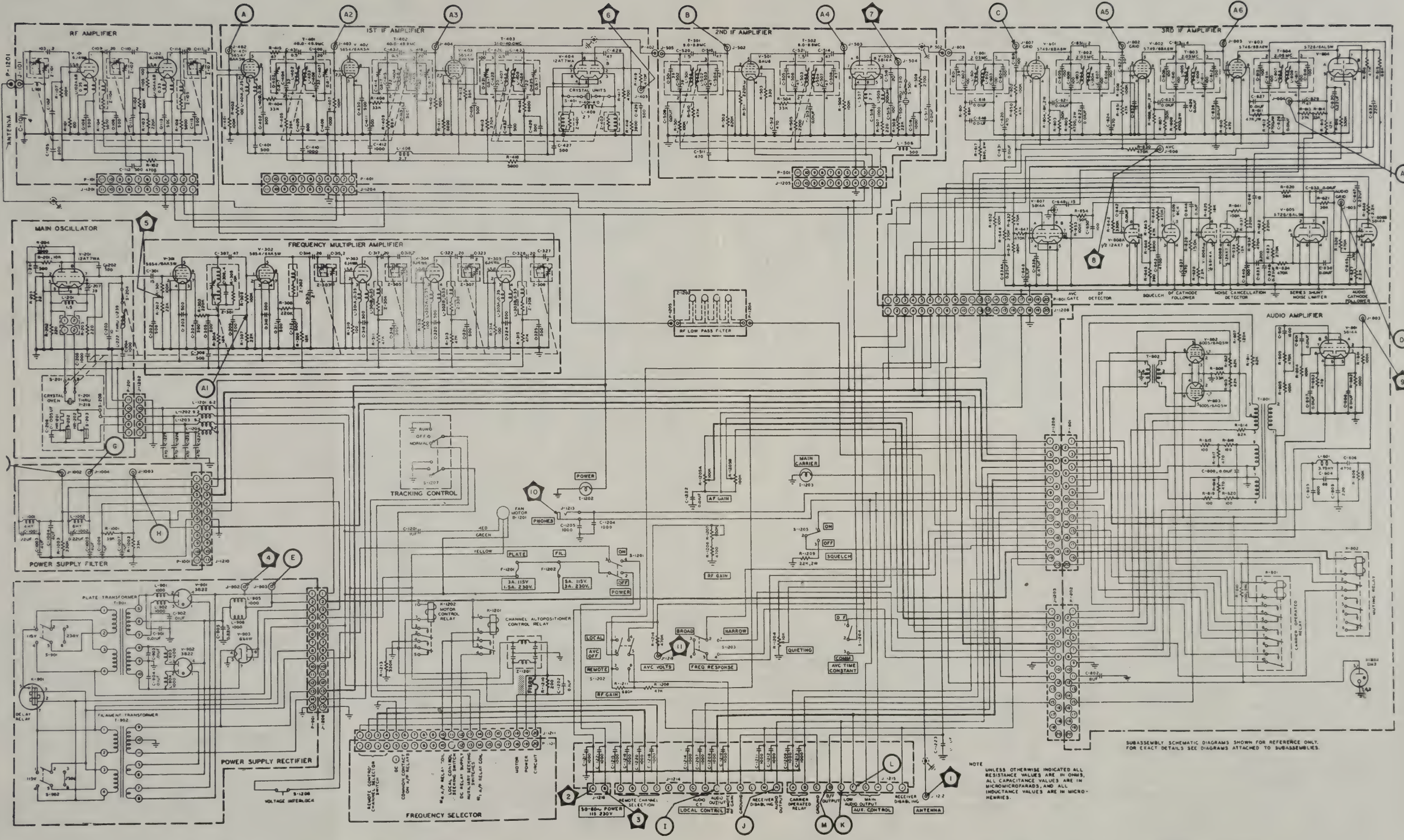


Figure 7-4. Radio Receiver R-278B/GR, Schematic Diagram

SECTION VIII
DIFFERENCE DATA SHEETS

(Not applicable)

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